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AN OUTLINE OF THE MINERAL RESOURCES OF ANDHRA DESA

(*Based on the Andhra University Extension Lectures delivered at the Mah[illegible] College, Vizianagaram and P. R. College, [illegible] n December, 1936.*)

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PREFACE

IT is well-known that minerals play the most important role in modern civilisation. All the development of the past century in manufacture, transport, engineering, warfare and the general amenities of life are directly connected with mineral products. The countries which have gone ahead of others in the skill with which they win and utilise mineral substances have become the great Powers, while the others, which are lagging behind, are either their political dependents or at best suppliers of raw materials.

It will therefore be clear that the economic regeneration and political importance of our country will depend in a very large measure on our ability to turn the potentialities of our resources to account. Mining in India dates back to great antiquity ; yet we possess only scanty information about our mineral resources. This, as pointed out by Sir Lewis Fermor, former Director of the Geological Survey of India, in his Presidential Address to the Indian Science Congress, is mainly due to the utterly inadequate provision for the thorough geological investigation of this vast sub-continent. European and North American countries, most of which have only a fraction of the area of our country to cater for, have much larger, more varied and more efficient personnel on their geological Surveys and Bureaux of Mines. Japan has become a front rank Power in the course of half a century, while Russia has, by a supreme effort, industrialised herself phenomenally in the course of barely twenty years. It is learnt, on reliable authority, that this country has organised a band of several thousand geologists and mineral technologists whose energies are directed towards mineral development and utilisation.

The little information that we possess about South Indian Geology and minerals is the result of the work of European

amateurs of the early 19th Century and a small but brilliant band of geologists of the Geological Survey of India. Andhra Desa is, mineralogically, one of the richest and most interesting units of India. What little mineral exploitation there is in the Madras Presidency is mainly in the Andhra Desa. The possibilities of this territory are great, but they have to be brought to light through the work of conscientious and enthusiastic geologists with as little delay as possible.

In the following pages an attempt is made to review briefly the information available, at present, of the mineral resources of Andhra Desa. The facts brought together have been gathered from the publications of the Geological Survey of India, especially La Touche's Annotated Bibliography of Economic Minerals, and various scientific journals, supplemented by personal observations extending over several years.

I have to acknowledge with pleasure the valuable suggestions given by Dr. M. S. Krishnan, Assistant Director of the Geological Survey of India, in the preparation of these lectures for publication. To him I owe a deep debt of gratitude for the guidance and help he constantly gave in my geological work, since my graduation from the Madras University. I am thankful to H. E. H. the Nizam's Government for according me permission to deliver the University Extension Lectures in the Andhra University and to publish the lectures; and to Dr. C. R. Reddy, Vice-Chancellor of the Andhra University, for kindly including the publication in the Andhra University Series.

HYDERABAD, DECCAN.
January, 1939.

C. MAHADEVAN.

TABLE OF CONTENTS.

CHAPTER I.

INTRODUCTION.

Rise of Modern Geology.

The problem of the origin and history of the earth has engaged the thoughts of mankind from the very earliest times. Primitive as well as more advanced cultures have speculated upon this subject according to their notions and varying understanding of natural phenomena. It is not our purpose here to go into early thought but only to give the results of modern scientific investigation, which was initiated barely 150 years ago. Much of the earliest observations were made in England in the realm of stratigraphy, *i. e.*, the study of rock formations, their mineral and fossil contents and their order of superposition and relative age, as will be recognised by all who have studied the elements of geology, since many of the standard stratigraphical units bear names derived from Great Britain. Sir Charles Lyell, one of the great pioneers, systematised the knowledge then available and wrote his "*Principles of Geology*", which is perhaps the earliest and best-known classic in geology. The work of the early pioneers has resulted in the adoption of a scheme of classification of rock groups, applicable practically to all parts of the World. It is naturally to be expected that the geologic record in different countries will vary to some extent in their nature and completeness, but by careful and systematic work, the records of different areas can be correlated and a general unity recognised in the apparent diversity of formations.

The Two Broad Divisions of Stratigraphy.

The rocks of the earth are divisible into two broad classes, namely those possessing no vestige or record of life (Azoic) and those in which fossils are recognised (Proterozoic, Palaeozoic, Mesozoic and Cainozoic).

Azoic Rocks.

The Azoic period contains no fossil remains and is divided into an earlier group called the Archaean and a later one consisting of un-fossiliferous sedimentary rocks called (in India) the Purana group. American geologists divide the Azoic period into an 'Archaeozoic' and a 'Proterozoic' era. Most geologists are now of the opinion that though no fossils have been discovered in the 'Azoic' rocks, life must have originated in the Archaean era. The limestones and carbonaceous shales are, to a great part, ascribed to organic origin. It is but reasonable to suppose that the prolific life, represented by the abundant fossils of the Cambrian times, must have taken a very long time to evolve to that stage of diversity and complexity; and many believe that primitive unicellular organisms must have flourished on the globe long before the Cambrian, *i. e.*, early in the Archaean era.

Value of Fossils.

A careful study of the fossiliferous formations has thrown very interesting light on the evolution of life on our planet and though there are wide gaps in this story, a general continuity is still apparent from the earliest to recent times. Each geological formation has some unique association of fossils which helps the stratigrapher to fix its age definitely. Thus, fossils are the best means for deciphering the geological history. The fossiliferous period is divided into three main eras, namely (1) Palaeozoic or ancient life period, (2) Mesozoic or middle life period and (3) Cenozoic (Cainozoic) or new life period.

India Divisible into Three Parts.

India is divisible into three geological units namely (1) the Peninsular India, (2) the Indo-Gangetic Plains and (3) the Himalayas and their extension to east and west. A major portion of Peninsular India is believed by geologists to have been a land mass from very early times. The Indo-Gangetic plain is geologically very recent, and consists of alluvia brought

down and deposited by Himalayan rivers. It is estimated that these alluvial formations have a maximum thickness exceeding 10,000 ft. Geological observation and geodetic survey point to the fact that this region was once the foreshore of the 'Tethys'—a sea which once occupied the Himalayan region, the thick sediments accumulated therein having been folded and raised up to form the mightiest mountain system of the World.

The Himalayas consist of fossiliferous sediments from palaeozoic upwards to geologically the most recent period. These sediments were accumulated in a sea separating the northern continent from the southern. This mediterranean sea has been called the 'Tethys'. Sedimentation and subsidence in this area must have progressed simultaneously, resulting in the accumulation of an enormous thickness of deposits. During comparatively recent geological periods, mountain building movements piled up the sediments, the horizontal movements and compression acting apparently from Central Asia towards the Indian Peninsula. The adjustment of crustal equilibrium following the mountain building movements is apparently still going on. For this reason, the Himalayan region and the bordering areas are unstable and earthquakes occur frequently in them.

Coming now to Peninsular India, though in a regional sense, it has been a land mass from the earliest times, there are areas within it where local subsidence and sedimentation took place. The rocks met with belong to the Archaean and the Purana groups, Gondwana system, the Cretaceous and some deposits of Tertiary or Cenozoic era.

Geological Formations.

(1) *The Archaeans:* The Archaeans are divisible into two main groups, a lower one consisting of schists of hornblende-mica and chlorite-schists with local associations of highly metamorphosed limestones, shales and quartzites, and a higher one consisting of granites, gneisses and other rocks which

have received the name of Peninsular gneissic complex. Some of these were definitely of igneous origin, *i. e.*, they had crystallised out of a molten magma, and others were sediments deposited in the ocean. Both have since been altered out of all recognition and recrystallised into new rock types. The former types of rocks are called the Ortho-gneisses and Ortho-schists and the latter, the Para-gneisses and schists. The schistose series has been called the Dharwar group of formations from the fact of their having been recognised first in the district of Dharwar in the Bombay Presidency. The Peninsular gneissic complex shows clear indication of being later in origin than the schistose series. The Dharwar formations as well as the Peninsular complex can be included under the term ' Archaean '.

(2) *The Puranas :* The next younger geological formations recognised in South India are a group of sedimentary rocks which show but little evidence of having been subjected to any great compressional or other change. They still retain the original characteristics acquired during deposition and induration and show but little deviation from the original position of deposition. These rocks are developed in the districts of Cuddapah, Kurnool and Guntur in the Madras Presidency, though outliers can be traced as far south as Chittoor and Nellore districts. In several parts of the Hyderabad State as well as in Orissa and Central Provinces including parts of the Vindhyan mountains, similar sedimentary rocks have been recognised, all of which have been included by Sir Thomas Holland under the term ' Purana group '. In the Madras Presidency, where they have been studied in some detail, they have been divided into two groups called the *Cuddapah and Kurnool* formations.

(3) *The Gondwanas :* The azoic period occupies a considerable length of time of the surface history of the earth. In Peninsular India there is a wide gap, subsequent to the deposition of the sediments in the Purana sea, till we come up

to what are called the Gondwana formations. The Gondwana formations are known to range from the uppermost periods of the Palaeozoic era to Jurassic times in the Mesozoic, and are only locally developed as fluvatile and estuarian deposits in restricted basins. They are the chief coal bearing formations of India and the Southern Hemisphere in general, and are so called, because they were first recognised in the forest region inhabited by the Gonds. From the evidence afforded by fossils, it is surmised that during the Gondwana times, there was land connection between India, South Africa, South America and Australia, and this great Southern continent is known to geologists as the Gondwana land. Floral and faunal affinities observed in the Gondwana formations of these countries, now separated by huge oceans, are to be explained only by postulating a land connection between them.

The Gondwana continent began to be disrupted towards the close of the Mesozoic or the beginning of the Cenozoic eras when Peninsular India took more or less its present outline.

(4) *The Deccan Traps:* The latest part of the Mesozoic era in Peninsular India is heralded by the advent of gigantic eruptions of lava-flows that covered a great part of Western and Central India, an area of over 2,00,000 square miles. Remnants of these lavas are found as far east as Rajahmundry. These lava-flows are called the *Deccan Traps* as they cover much of the Deccan and give rise to stepped topography. 'Trap' is a Scandinavian term meaning 'Step'. The activity of the Deccan Traps continued well into the Cenozoic era.

Interbedded among the successive horizontal lava-flows, are local lacustrine deposits whose fossil contents enable us to assign the age of the Deccan Traps.

(5) *Marine Transgressions :* A free marine transgression in the upper Mesozoic on the coastal regions of Pondicherry and in the Trichinopoly district, is responsible for beds yielding a rich marine cretaceous fauna.

In the next chapter, a brief sketch is given of the geological history of Andhra Desa, with which we are particularly concerned here.

CHAPTER II.

GEOLOGICAL OUTLINE OF ANDHRA DESA.

The Andhra Desa forms a distinct geographical entity based on linguistic and cultural background and consists of the districts of Ganjam, Vizagapatam, Godavari, Kistna, Guntur, Nellore, Chittoor, Bellary, Cuddapah, Kurnool and Anantapur. In the following paragraphs, the main geological features of the above area are very briefly described.

The Archaeans.

The oldest geological formations in the area are the Archaeans. These are believed to be the earliest rocks of the earth. As pointed out in the first Chapter, two distinct phases are recognised in them, *viz.*, the schistose and the gneissic. The schist phases are now recognised to be the earliest members of the archaean rocks. Geologists are still not agreed as to whether these are original sediments now completely metamorphosed, or if they are of igneous origin. It is probable that some of the members of the schistose series are of sedimentary origin and others of igneous origin.

The Schist Series.

These are called the Dharwar series in Southern India on account of their first having been recognised in the Dharwar district of the Bombay Presidency. They occur as narrow elongated patches amidst the gneisses and are highly compressed forming foliated schists. The different types generally recognised in this group are hornblende-chlorite-talc or mica-schists. These are cut in places by quartz veins which are often mineral-bearing. These schists are well developed in Bellary, Anantapur and Nellore districts and their exact disposition may be seen on the map. The manganese mines at Sandur in Bellary district, the gold mines at Anantapur, the copper deposits in portions of Nellore and in the Ceded districts are all to be found in the schistose formations. The mica pegmatites in Nellore likewise cut through the schists and the mica is believed to owe its origin ultimately, at least in

part, to the schist band. The Dharwar formations are the most important mineral-bearing rocks in South India.

The gneissic group lends itself to a division into two broad classes in the districts comprising Andhra Desa.

The Gneissic Group-Khondalites.

Firstly, we have the so-called Bezwada gneisses which has been described by Walker under the name of Khondalite from the fact that they are typically developed in the Agency tracts inhabited by the Khonds. These extend from the Ganjam district through Vizagapatam up to Bezwada. The Khondalites are very probably original sediments that have completely been altered into the present gneissic condition by metamorphism, *i. e.*, by heat and pressure. The occurrence of minerals such as sillimanite, kyanite, cordierite, graphite and garnets in the formations is clearly suggestive of their original sedimentary origin. The Khondalites are intruded by 'Kodurites' (which are manganese-rich mixed rocks of sedimentary and igneous origin) and to a minor extent by granitic and other rocks belonging to the 'Charnockite group'. The manganese deposits of Vizagapatam district are associated with the so-called "Kodurites" which are rich in manganese minerals. The crystalline limestones and marbles associated with Khondalites in the neighbourhood of Anantagiri in Vizianagaram Samasthanam and in Jeypore Samasthanam, also support the surmise that the Khondalites were derived from original sediments.

Included in the gneissic series are also granitoid gneisses. These are well developed in parts of Bellary, Guntur, Nellore,

Granitoid Gneisses-Ortho Gneisses.

Cuddapah and Kurnool districts. Several types have been recognised in this series also, but in the absence of detailed geological survey they have not been clearly classified. They are not rich in minerals of economic value, but yield excellent building stones and road material, and are believed to be original plutonic or deep-seated igneous rocks on which metamorphic agencies have induced the gneissic structure.

The Charnockites.

The Charnockite series constitute an important group in the archaean rocks and occur as intrusive plutonic rock in several parts of South India. These rocks give rise to the hills of Nilgiris, the Palnis and the Shevaroys. They occur as well defined bands in Vizagapatam and Ganjam districts. Sir Thomas Holland was of the opinion that these charnockites constituted a distinct '*Petrographic province*' in the Archaean system, which showed evidence of magmatic differentiation, since he recognised different types varying from ultra-acidic to ultra-basic. Except as building and road stones, these rocks are not of great economic importance.

General Economics of the Archaean System.

We may here review the general mineral possibilites in the archaean group of rocks in the area under consideration. As has already been pointed out, the schistose series are responsible for all the gold, most of the manganese, copper, asbestos, soap-stones and some iron, which were all exploited during the historic periods and some of which are still mined. This region has not been geologically surveyed in detail, and needless to say, detailed prospecting has been confined to a few patches which have been worked in recent years. Authentic reports exist of the discovery of such important minerals as sillimanite, kyanite, graphite, phlogopite, cordierite and other semi-precious stones in the Andhra Desa. Possibilities in these rocks are considerable, and a good deal of search and investigation are necessary to bring them to light and take steps to develop them.

The Purana Group-Cuddapah and Kurnool Formations.

Over a greater part of the districts of Cuddapah and Kurnool and the Palnad of Guntur district, sedimentary formations of pre-Cambrian age are met with. Their exact extent is indicated on the geological map. It has been computed that these two formations together constitute a thickness of about 22,000 ft. The sediments are believed to have been laid down in an inland sea. The nearly complete

absence of disturbance in these beds point to the tranquility through which Peninsular India passed, since pre-Cambrian times. The metamorphism to which these rocks have been subjected is, if at all noticeable, of a low grade. The formations consist of sandstones, shales and limestones and constitute some of the important mineral bearing strata in Andhra Desa. Who has not, for instance, heard of the world famous Golconda Diamond Mines from where Koh-i-noor and other valuable diamonds had originated? Golconda was the diamond mart for several centuries, though the mines were all situated mostly along the Kistna river in parts of Guntur and Kurnool districts and Hyderabad State.

Cuddapah Formations.

The Purana group is divided into two series, of which the lower one is called the Cuddapah formation and consists of four sub-groups. The lowermost of these is called Papaghni beds, the next the Cheyair beds, the third the Nallamalai beds, and the topmost, the Kistna beds. The maximum total thickness of all these four groups is computed at about 21,000 ft. The eastern margins show structural disturbance in the beds, but towards west they are more or less horizontal. The Cuddapah rocks are the main store-house of the mineral wealth of the Purana group. Iron, copper and lead were mined in historic times in these; though the present activity is negligible, a careful prospecting of the area should yield valuable results.

Kurnool Formations.

The Kurnool formations, or the upper group of Puranas, are divided into four sub-groups, the lowest of which is the Banganapalli, the next higher, the Jammalamadgu, the third, the Paniam and the fourth, the Kundair beds, and attain a maximum thickness of about 1,200 ft. Most of the diamond mines are situated in the lowest of the Kurnool formations, *viz.*, the Banganapalli beds.

Brief reference may be made to the economic resources of the Cuddapah and Kurnool formations. It is noteworthy that

during historic times the area was extensively mined even though geology as a science had then made little progress. An important economic product afforded by the Purana group within our area is building stone. The so-called Cuddapah slabs are slaty limestones that occur both in the Cuddapah and the Kurnool formations and have been used extensively for flooring and roofing all over the Madras Presidency. The limestones occur in different shades of colour and some of the beds in Palnad afford exquisite decorative material. It is a pity that these Palnad limestones have not had as much publicity as they deserve.

Raw materials for the cement industry are found in abundance. The Palnad area is especially worthy of note, but there are also other places which might receive attention. In the absence of coal, water power can be developed in the area. The presence of diamonds in the lower part of the Kurnool formations is well-known and this area has yielded most of the best known diamonds. Golconda and Wajrakarur are names famous throughout the world. Copper and lead ores occur in a few places and are worthy of further examination. Lenses and beds of iron ore are found in the Cuddapah and Kurnool formations in the districts of the same name. It would appear that a well-organised survey of the mineral possibilities would be amply repaid since some of the known deposits as well as others yet to be discovered, should prove workable.

Gondwana System.

There is a great gap in the geological record of South India after the deposition of the Cuddapah—Kurnool systems in the so-called Purana Sea. The entire absence of the early formations of the palaeozoic or "ancient life" period in South India is due to the fact that the country was *terra firma* and has been a land mass since the earliest geological era.

South India was a land mass when sedimentation was progressing most actively in the " Tethys " sea, now occupied by

the Himalayas, separating Peninsular India from the northern parts of Asia.

During the Carboniferous, Permian, Triassic and Jurassic periods which are the topmost divisions of Palaeozoic and the earlier part of Mesozoic era, some fluviatile, lacustrine, estuarian and terrigenous deposits in local areas were formed, which are known by the name of the Gondwana System. These are the chief coal bearing rocks of India. Belts of Gondwana formations are developed in several areas in Andhra Desa. They are best seen in parts of Godavari district, though minor patches are recognised in Kistna, Guntur and Nellore districts.

The Lower Gondwanas.

The Gondwanas are divided into a lower and an upper group. They are the earliest fossiliferous formations in South India and contain remains of extinct reptiles and other animal and plant fossils. The lower Gondwanas in Godavari district are coal-bearing and are the continuation of the Singareni Coal belt. The basal beds of the Lower Gondwanas, called "*Talchirs*", are found as patches near Dummugudem and Bhadrachalam and between Bhadrachalam and Rekapalli. They consist of fine grained greenish sandstones and micaceous shales. The Talchirs are overlain by coal-bearing "*Barakars*" which occur in Godavari district in a series of bands. The first of these is located at the Junction of Talperu with Godavari near Lingala, the second below Bhadrachalam near Devarpalli and the third at Badathanoor (Bedadanuru). The Barakars are succeeded by the *Kamthi group* which locally go by the name of *Chintlapudi sandstones.* They are somewhat felspathic and most of these rocks rest directly on the gneisses. At Kunlacheru about 16 miles north of Ellore, some fossils have been found in the formations which help us to fix their horizon. The economic possibilities of these rocks have not been fully explored and there seems to be every possibility that careful prospecting would reveal workable seams of coal in the Godavari district. In any scheme for the

industrialisation of Andhra Desa, a thorough prospecting for coal in the Lower Gondwanas of the Godavari district would be a prime necessity.

The Upper Gondwanas.

These are best developed in Guntur, Kistna and Godavari districts along the coastal region. The Upper Gondwana rocks are divided into three stages, *viz.*, the *Golapalli sandstones*, the *Raghavapuram shales* and *Tirupati* (*Tripety*) *sandstones*. All these are littoral or shoreline deposits. They contain innumerable plant and animal fossils. The Golapalli sandstones which are best developed in Godavari district, consist of reddish brown sandstones and grits. The Raghavapuram sub-group consists of shales and the Tirupati series, of sandstones. All these are economically unimportant, but on account of the rich find of fossils, are of great academic importance. Several publications have been devoted to the study of these fossils by the Geological Survey of India.

The Deccan Traps.

Over a great part of Western India, an extensive formation of basalts which goes by the name of '*Deccan Traps*' masks the earlier geological features. Their maximum thickness is computed to be about 10,000 feet. They are mostly basic lavas which flowed in a molten state through extensive fissures and formed a series of layers covering a very large area of South India. The total extent of Deccan Traps in India is estimated as over 200,000 square miles. Though normally the volcanic activity was confined to the north-western parts of South India, and they outcrop as far as the eastern and south-eastern districts of H. E. H. the Nizam's Dominions, a few outliers of these formations are met with near Rajahmundry and Nidadavole. These are evidently the south-easternmost extension of the basalts and occur on both sides of the Godavari, (in East Godavari district) and contain amygdales or cavities filled with beautiful hydrated amorphous silica such as agate and chalcedony which are valued much as semi-precious stones. In between the Deccan Trap layers are seen lacustrine formations in

which floral and faunal fossils of estuarian affinity abound. Blanford considered the Deccan Traps of this area as belonging to the top-most series of Mesozoic or middle life period, namely the Cretaceous system. Recent studies of the fossils in this area however seem to indicate a later age for these formations. The fossil beds are observed at Kateru, Dudkur and Pangudi. Except for these isolated instances, Deccan Trap outliers are practically absent in the Andhra Desa.

The Rajahmundry Sandstones.

The next geological formations met with in the area are the Tertiary sandstones which go by the local name of *Rajahmundry sandstones.* These are homotaxial with the Cuddalore beds and are considered to be geologically very recent. They occur in isolated patches near Rajahmundry and north of Tadepalligudem, in the southern part of Nuzvid Zamindari and in several parts in Nellore district. In the Godavari district the sandstones show lithological affinity to the Cuddalore sandstones and vary from shaley sandstones to conglomerates, the prevalent colours being reddish, pink and yellow-brown. Some of them are highly ferruginous and have been utilised as raw material for indigenous iron industry by local smelters. In Nellore they are more lateritic. These tertiary sandstones are of great academic significance in that they tell us the approximate age of the breaking up of India's land connection with Australia, South America, Madagascar and Africa. It is clear from the fossil evidence afforded by Rajahmundry sandstones that this must have been at some time during the first half of the Tertiary or new life period. The South Indian coastline may practically be considered to have attained its present general shape during this time.

Recent Deposits and Laterites.

These are generally found occupying the high elevations in the Agency Tracts and in several areas in the Andhra Desa. These laterites vary so much in composition that it may be possible in this group to get ores of aluminium as well as of iron.

On account of the laterites hardening by exposure to atmosphere, they are used extensively as building stones.

Taking a regional view of the geology of the Andhra area, it is noted that it consists of formations yielding or capable of yielding valuable economic minerals. All the work done so far has been superficial, the scope of the survey being often to define roughly the limits of various geological formations. Except for the exploitation of some of the manganese in the Vizagapatam district and the half-hearted mining of mica by admittedly crude methods in Nellore district, it may be safely said that the resources are practically untouched.

CHAPTER III.

PART I.

REPORTED OCCURRENCE OF MINERALS IN ANDHRA DESA.

Introduction :—In this Chapter are recorded fairly full particulars of the minerals reported from several localities in the Andhra Desa. It is scarcely necessary to point out that the mere occurrence of any mineral does not indicate that it is available in workable quantities. The idea of referring to all the available literature is to enable interested prospectors to direct their attention to such areas and examine the economical possibilities. The index volumes and other publications of the Geological Survey of India* have been extensively used in preparing a list of the reported minerals with their localities, with a view to enable the reader to get at the authorities who have reported on these minerals. A bibliographic index has been added which indicates the publications in which the authors have discussed the occurrence of the minerals. The reference numbers accompanying the names of the authors in the Chapter refer to the bibliography appended to the Chapter. (Part ii.)

ANTIMONY.

Bellary.—Ramandrug (15° 8′ : 70° 32′). Crystals of sulphide of antimony are disseminated among the schists of the Sandur hills near Ramandrug [1], but further particulars, particularly relating to its abundance, are not stated [2] (P. 164).

Cuddapah.—Jangamrajpalli (14° 46′ : 78° 56′ 32″). Newbold [3] states that antimony is found in the Nallamalai hills near Jangamrajpalli, where lead mining was carried on in former times.

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* Most of the particulars recorded in this Chapter have been taken from La Touche's Bibliography of Indian Geology (annotated Index of minerals of Economic Value).

Vizagapatam.—Kodur (18° 16′ : 83° 37′). Carmichael[4] thought that antimony minerals occurred here. Specimens of the ore were exhibited at the Madras Exhibition of 1857[5]. A. Scott[6] however showed that this was really manganese ore, though it is locally used as a cosmetic.

ASBESTOS.

Asbestos occurs in association with Vaimpalli limestones and shales (Cuddapah formations) and interbedded doleritic and basaltic sills in several localities in parts of Ceded districts. The asbestos zone is said to be up to about 3 ft. thick generally at the contact of the basic sills and the Vaimpalli beds overlying them, the latter being serpentinous limestones. The serpentinous zone is probably due to the interaction between the basic igneous rock and the magnesian limestone. The following are the important localities; and for further information a recent paper by Coulson[7] may be consulted :—

Cuddapah : Pulivendla Taluq : Brahmanapalle.
Lopatanubulu area.
Kamalapuram Taluq : Rajupalem.

Kurnool : *Dhone Taluq* :—Chandrapalle, Kochcheruvu-Kamalapuram, Chinna Malkapuram, Kotapalle, Mudduleti-swami, Betemcherla.

Kurnool Taluq :—Jaharapuram.

BARYTES.

Nellore :—Narravada (14° 54′ : 79° 29′). H. C. Jones[8] has described an outcrop found about 3 miles east of this village, and occurring amidst the mica schists. There are also disseminations of the mineral for some distance on either side of the vein systems.

Barytes occur in the Ceded districts[9] generally in association with Vaimpalli slates and limestones (Cuddapah formations) and interbedded basic intrusive rocks. It is found

both as replacements in the Vaimpalli limestone and as fissure fillings in the fissures traversing limestone and the basic rocks. Barytes deposits occur in the following areas :

Cuddapah District: *Cuddapah Taluq.*

Mittamidapalli	(14° 25′ 30″	:	78° 44′).
Chimalapenta	(14° 26′	:	78° 35′ 30″).
Uppalapalli	(14° 26′	:	78° 31′ 30″).

Kamalapuram Taluq.

Rajupalem	(14° 26′	:	78° 31′).

Pulivendla Taluq.

Nandipalli	(14° 22′ 30″	:	78° 24′ 30″).
Kottapalli	(14° 22′	:	78° 21′ 30″).
Bakkannagaripalle	(14° 20′	:	78° 22′).
Midipenta	(14° 20′	:	78° 19′).
Rachegaripalli	(14° 21′	:	78° 19′).
Elamvaripalli	(14° 23′ 30″	:	78° 14′).
Ippatla	(14° 25′ 30″	:	78° 11′).
Karnapapayapalli	(14° 32′	:	78° 4′ 30″).

Razampeta Taluk.

Razampeta	(14° 14′	:	79° 38′ 30″).

Anantapur District.

Barytes areas in the Anantapur are noted below :

Tadpatri Taluq.

Nerijamupalle	(14° 32′ 30″	:	78° 1′).
Rangarajukunta	(14° 42′ 30″	:	77° 56′ 30″).
Madugupalli	(14° 42′ 30″	:	77° 54′).
Dosaledu	(14° 46′ 30″	:	77° 54′ 30″).
Mutssukota	(14° 51′	:	77° 52′ 30″).
Tabjula	(14° 54′	:	77° 49′ 30″).
Chandana	(15° 5′	:	77° 49′).
Lakshumapalli	(15° 7′	:	77° 49′ 30″).

Anantapur Taluq.

Venkatampalle	(14° 47′ 30″	:	77° 50′).

Gooty Taluk.

Krishtipadu	(15° 4′	:	77° 46′ 30″).

Kadiri Taluq.

Mudigubba	(14° 21′	:	77° 59′).

Barytes occurs in a very large number of localities in *Kurnool district*, which are enumerated below:—

Dhone Taluq.

Nallamekalapalle	(15° 7′ 30″	:	77° 47′).
Narayanapuram	(15° 9′ 30″	:	77° 47′).
Peddapaya	(15° 10′	:	77° 50′).
Chandrapalle	(15° 12′ 30″	:	77° 49′).
Hussainpuram	(15° 14′	:	77° 49′ 30″).
Rangapuram	(15° 16′	:	77° 49′).
Ramapuram	(15° 17′	:	77° 52′).
Kochcheruvu	(15° 19′	:	77° 51′ 30″).
Dharmavaram	(15° 21′ 30″	:	77° 53′).
Karanapikunta	(15° 21′	:	77° 54′ 30″).
Kamalapuram	(15° 21′	:	77° 56′).
Erragunta	(15° 23′	:	77° 56′).
Valasala	(15° 23′ 30″	:	77° 58′ 30″).
Chinna Malkapuram	(15° 22′	:	77° 58′ 30″).
Kottapalle	(15° 22′ 30″	:	78° 2′ 30″).
Bukkapuram	(15° 23′	:	78° 2′).
Rahimanpuram	(15° 24′	:	78° 3′).
Ambapuram	(15° 23′	:	78° 5′ 30″).
Gutupalle	(15° 25′ 30″	:	78° 3′).
Husainpuram	(15° 26′ 30″	:	78° 3′).
Tapasikonda	(15° 27′ 30″	:	78° 3′ 30″).
Papasanikottala	(15° 27′ 30″	:	78° 4′ 30″).
Komururikottala	(15° 26′	:	78° 5′).
Balapalapalle	(15° 27′ 30″	:	78° 6′ 30″).
Musalayyacheruvu	(15° 29′ 30″	:	78° 4′).
Kolumalapalle	(15° 28′ 30″	:	78° 8′).
Gattimanikonda	(15° 32′	:	78° 11′).
Boyanapalle	(15° 32′ 30″	:	78° 8′).
Veldurti	(15° 33′	:	77° 56′).

Kurnool Taluq.

Uyyalavada	(15° 37′ 30″	:	78° 5′).
Gadidemadugu	(15° 46′ 30″	:	78° 9′).

Nandyal Taluq.

Gani	(15° 40′	:	78° 19′).
Basavapuram	(15° 24′ 30″	:	78° 38′).

Sirvel Taluq.

Tallalingamdinna	(15° 11′ 30″	:	78° 36′).

Cumbum Taluq.

Janapalacheruvu	(15° 28′ 30″	:	79° 9′ 30″).

Nandikotkur Taluq.

Musalimadugu	(15° 58′	:	78° 26′).

BAUXITE.

Vizagapatam.—In his Presidential address to the Mining and Geological Institute of India, delivered in 1907, Holland[10] discusses the prospects of utilising the Indian deposits of bauxite. In the Vizagapatam hill tracts and Jeypore there are large areas occupied by Khondalites, which are known to give rise to bauxite and aluminous laterite. So far, however, no good bauxite has been reported from this area. Dr. C. S. Fox[11] visited the Korapat Hill (18° 47′ : 82° 42′) and the neighbourhood of Umarkot (19° 40′ : 82° 11′) but reported that no bauxite was to be found. It is thought that detailed geological survey of the area may reveal the presence of deposits of this mineral.

Bauxite is the raw material for the manufacture of aluminium. It is also used as a decolouriser in the petroleum industry and for making abrasives. Should any deposits be located, the potential water power resources of the hill tracts can be tapped for the establishment of an aluminium industry.

BUILDING MATERIALS.

Bellary.—Foote[12] has given an excellent account of the building and ornamental stones found in the district, the

appendix to this paper containing a full list of granite quarries. The following localities and varieties of stone, are especially mentioned :—

Dammur (15° 18′ : 76° 59″). Granite of a rich deep red colour, of medium to rather coarse grain; a superb decorative stone if well polished.

Torangal Hill (15° 12′ : 76° 44′).

Kurikuppa Hill (Koreekoompa) (15° 13′ : 76° 43′. Dark grey to blackish porphyry, with bright flesh-coloured crystals of feldspar of large size.

Kapgal Hill (15° 12′ : 77° 2′ 30″). Grey Granite.

Hurlihal (14° 43′ : 76° 37′). A blackish green porphyry with rich green crystals of feldspar. The dyke is over two miles long, and of considerable width. Similar porphyry occurs at Kallakurti (14° 47′ : 77° 9′).

Timappagarh (Timmangarh 15° 8′ : 76° 37′) in the Sandur Hills. Riband Jasper varying in colour from bright scarlet to delicate pinkish white or deep red and purple, highly suitable for inlaid work. Similar rocks also occur at Ubbalagandi (15° 3′ : 76° 43′) and on the path leading up to the Donimali plateau from Ettinahalli (15° 8′ : 56° 40′ 30″).

Nemkal (15° 1′ : 77° 0′)
Metra (15° 19′ : 76° 41′) } Green quartzite.

Nilgunta Hill (14° 44′ : 74° 58′)
Angur (14° 57′ 30″ : 75° 49′) } Potstone occurring here has
Harappanahalli (14° 47′ 30″ : 76° 2′ 30″)

been used in the construction of several temples in the neighbourhood. Though a comparatively soft stone for building, it is easily worked and suitable for carvings.

Huvina Hadagalli (15° 1′ : 75° 59′ 30″)
Tallur (15° 10′ : 76° 40′ 30″) } Grey or white crystalline limestone occurs amidst the Dharwar series, but only in small quantity.

Cuddapah.—The principal building material of the district is derived from the Nerji Limestone formation, which covers an extensive tract. The stone is very compact, and extremely fine grained, with a wide range of colours, from bluish grey to black. Some verieties are capable of taking a high polish. The stone has been quarried on a large scale at Nerji (14° 39′ : 78° 35′), and some of it has been used in the Madras University Buildings.[13 & 13A]

Slates from which thin slabs can be obtained, occur in some of the beds of the Cuddapah System.[14]

Godavari.—The sandstones occurring in the low hills at Peddapuram (17° 5′ : 82° 12′) have been quarried extensively.[15]

Guntur.—Handsome varieties of granitoid gneiss might be quarried in the Kondavidu hills (17° 16′ : 80° 20′), but so far as known it has been used only to a limited extent in rough work.[16]

The limestones of the Kurnool formation found on the banks of the Kistna river between Warapalli and Amaravati (16° 35′ : 80° 25′) are largely used for building.[17] Parts of the formations are capable of yielding excellent marbles for decorative purposes.[18]

Kistna.—The Cuddapah and Kurnool formations of this district contain limestones, some of which are marbles of excellent quality [19]; and others have been used for the manufacture of lime. The different sandstone groups of the Gondwana system also yield excellent building stones. A buff sandstone is found at Tundkalpudi (16° 54′ : 81° 14′). Janampet (16° 46′ : 81° 7′) and other places, while a fine red sandstone has been noted near Peddavegi (16° 48′ : 81° 10′).

Kurnool.—The Nerji limestones which occur throughout the Khundair valley have been widely used for building purposes.[20]

Serpentinous limestones of pale green and yellowish colours, occasionally darker green with convoluted laminae, occur near Kurnool (15° 50′ : 78° 6′) and at Kadrabad, 3½ miles to the south-east. These would give a handsome, finely clouded marble[21], highly suitable for ornamental purposes.

Nellore.—Granitoid gneiss is very widely distributed in this district, of which a pinkish grey variety is quarried to some extent at Kuchupudi Hill (15° 28′ : 79° 44′). It is interesting that this was formerly used for making cart wheels.[22]

Vizagapatam.—Pink and white dolomitic limestones occur near Kondajori (18° 57′ : 82° 19′) in the Jeypore Zamindari. White dolomitic limestone of the neighbourhood of Borra would be an excellent marble for statuary and for decorative purposes. It is generally uniform in grain, compact and fairly hard.

Potstone is quarried to a small extent for building and other purposes near Ontagaon (18° 52′ : 82° 35′) to the west of Jeypore[23].

Charnockite.

The charnockites occurring in the ghats of Vizianagaram, Vizagapatam Agency and Godavari will form an excellent stone for building purposes. Light grey and dark grey varieties are available. In some places the rock is porphyritic *i.e.*, it contains large felspar crystals set in a finer grained matrix and it should make a beautiful stone for decorative purposes. Such a stone is found, for instance, near Anantagiri and Sunkarimeta.

Khondalite.

Usually khondalite is weathered to a rather brown, spotted and friable stone. The fresh stone is hard and will make a good building stone for which purpose it is frequently used in Vizagapatam and Waltair. As it is found all along the ghats in Vizagapatam, Godavari and Kistna districts, it is easily available in large quantity for ordinary building purposes.

COAL.

Along the upper reaches of the Godavari river in the district of the same name are three areas of coal-bearing rocks. W. T. Blanford[23A] found coal in four places around Lingala (18° 1′ : 80° 50′) occupying an area of about 5 square miles. There are here two 2-foot seams in the Godavari district side of the river, one 5-foot seam in the middle of the river and one 2-foot seam on the Hyderabad side. A pit was excavated here in 1891 in which a 5-foot seam was encountered. It has been estimated that the field contained about 8 million tons of recoverable coal of saleable quality.[23B]

The Totapalle field[23C] (17° 37′ : 81° 4′) has an area of 16 square miles of which about 10 square miles may contain workable coal. In one 86-foot borehole, two 3-foot seams were met with. A pit near Rajahrompalli showed a seam 5 ft. 6 in. thick. This field is estimated to contain some 24 million tons of fairly good coal.

The third field at Bedadanuru[23D, E] (17° 14′ : 81° 14′) has an extent of 5·5 sq. miles. Four seams were encountered in a borehole, of which only one about 4 ft. 6 in. thick is considered workable. The Barakar rocks are much thicker than the depth (186 ft.) reached by the borehole and hence there are good possibilities of finding better seams at depths.

It is also worth mentioning here that coal bearing rocks exist under the Chintalpudi sandstones. Hence the area between Bedadanuru and Chintalpudi is worth investigation.

COPPER.

Bellary.—Newbold has given accounts[24] of the occurrence of green carbonate of copper on a ridge below the southern scarp of the Copper Mountain, 5 miles to the west of Bellary. Here the carbonate occurs as thin veins and laminæ amidst the ferruginous slates. Excavations made apparently during the time of Sultan Hyder Ali on the crest of the mountain ore were then visible[25].

Foote[26] examined the area in 1896 but could find no traces of copper ore on the mountain. In another publication[27] he mentions the occurrence of thin films and veinlets of green copper carbonate in a quartz reef about a mile to the N. N. W. of Harappanahalli (14° 47′ 30″ : 76° 2′ 30″) where there are vestiges of an old mine. Copper stains were also found by him in a brecciated quartz reef at the crest of the Siddapan Konda ridge, 2½ miles E. by N. of Hallalgundi (15° 29′ : 77° 7′).

Cuddapah.—Traces of copper ore are mentioned by Newbold[28] and Foote[29] as occurring in the old lead mines at Jangamrajpalli or Baswapur (14° 46′ : 78° 57′) in the Nallamalai hills of the Cuddapah district. Impressions, apparently to be attributed to the original presence of copper pyrites, are to be seen in quartz veins in siliceous limestone[30].

Guntur.—Gantlapalem or Agnigundala (16° 11′ : 79° 48′). According to Foote[31], malachite and azurite occur as films on the joint planes of a bed of very coarse granular quartzite in the vicinity of the village, where there had been mining activity in former times. The locality was also visited by Heyne[32].

Kurnool—Copper ores have been described by Foote[33] as occurring at the following localities:—

Gumankonda (15° 38′ 30″ : 75° 21′). In an old pit sunk in a quartz vein at the western end of the valley, fragments of quartz coated with thin films of malachite were found. The vein appeared to have been entirely worked out[34].

Somadalpalli (Somayazulapalli: 15° 35′ : 78° 14′). Disseminations of minute grains of copper pyrites and thin films of copper carbonate have been noted as occurring in a quartz vein, 4½ ft. to 5 ft. thick, at the foot of the hills east of the village[35].

In the Kurnool Manual[36] published in 1886, it is stated that copper ore was formerly worked near Gani (15° 40′ : 78° 22′ 30″) and that bell-metal was manufactured here in the days of Rama Raja, a Jaghirdar under the Vijayanagar dynasty. The neighbourhood of Gujjalakonda (15° 45′ : 79° 27′) and Kommemarri (15 12′ : 77 55′ 30″) also reveal the presence of small amounts of copper minerals.

Nellore.—Extensive old workings for copper ore have been found in several places in Nellore, particularly near Garimanipenta (14° 59′ 30″ : 79° 37′) Benjamin Heyne published an account of these in 1814[37]. Thomson[38] described specimens collected by Heyne. One of these, an anhydrous carbonate of copper, was called Mysorin by this author. Several attempts were made by European prospectors in the first half of the 19th century to work the ores, but all of them proved unsuccessful. Accounts of the copper ores of the district have been given by several writers[39], notably by Calder, Prinsep, Ouchterlony, Newbold, Oldham, Mallet, King and Foote. King notes that all the attempts were confined to the oxidised zone where the ores were mixtures of carbonate, silicate and secondary sulphide. The ore is found as stringers and pockets in bands of hornblendic and garnetiferous schists, associated with trap rocks.

According to Sen Gupta[40] there are three groups of occurrences around Garimanipenta, *viz.*, Garimanipenta, Kovaripalli and Nilghenny, the whole area occupying some 10 sq. miles. The rocks at Garimanipenta are mica gneisses and altered basic rocks. A quarry 40 ft. deep shows two zones of the basic rocks containing irregular veins and pockets of copper ore—malachite, chrysocolla and oxides. Chalcopyrite has also been occasionally noted. In the other two groups of deposits, the ore is found in mica-gneisses. Some samples of the ore are very rich, analysing 30% copper. No information is available as to the quantity of the ore available or its extension below the oxidised zone.

Other localities in the district are in Pamur Taluq in Kalahasti Zamindari, Narasimhapuram in Udayagiri Taluq and near Gogulapalli[41] (15° 15′ 30″ : 79° 22′ 30″). The deposits received some attention at the hands of the Geological Survey of India during the War. In recent years a company was floated to work the deposits near Garimanipenta who seem to have used geophysical methods of prospecting. The results of the exploration have however not come to light though a small production has been recorded in 1926, 1927 and 1932.

CORUNDUM

Corundum is found in several places in the Madras Presidency, the more important occurrences being outside the Andhra area. An excellent account of the distribution of corundum in India is given by Holland[42] and of abrasive materials by Balfour[43]. The chief occurrences in the Andhra Desa are in the following places in the Anantapur District, where the corundum is found as scattered fragments on the ground. It is associated with either ultrabasic or syenitic rocks:—

Anantapur Taluq.

Atmakur	(14° 38′ 30″ : 77° 26′).
Danduvarapalli	(14° 39′ 30″ : 77° 46′).
Paramatiyaleru	(14° 40′ : 77° 26′).
Pasalur	(14° 39′ : 77° 44′).
Reddipalli	(14° 43′ : 77° 44′ 30″).
Siddaramapuram (?)	
Thimmapuram	(14° 42′ : 77° 27′).

Dharmavaram Taluq.

Maddalcheruvu	
Sivapuram	(14° 26′ : 77° 26′).
Motalachintarpalli (?).	

Kalyandrug Taluq.

Manirevu	(14° 36′ : 77° 22′ 30″).
Nutimadugu	(14° 29′ : 77° 23′ 30″).
Oblapuram	(14° 37′ : 77° 22′).
Palavenkatapuram	(14° 33′ : 77° 24′).

GEM-STONES—AGATE—AMETHYST—APATITE.

Godavari.—Benza[44] states that large quantities of agate, jasper and carnelian pebbles are collected from the bed of the Godavari river near Bhadrachalam, Rajahmundry (Rajamahendri) and other places.

Guntur.—Pebbles of agate, onyx, carnelian etc., are found in the alluvium of the Kistna river in the Palnad[45].

Vizagapatam.—Fermor[46] mentions a discovery of apatite crystals, of a beautiful deep sea-green colour, at Devda (18° 15′ : 83° 37′ 30″). The crystals measure up to 5 ins. in diameter, and occur in a garnet-felspar rock. Several hundredweights are said to have been obtained. A veinlet of lavender-coloured apatite was also found in garnet rock at the manganese mine of Kodur (18° 16′ 30″ : 83° 36′ 30″) but the mineral is much flawed[47].

GEM STONES—DIAMOND.

Anantapur.—Wajra Karur (15° 2′ : 77° 27′). Considerable interest was aroused about the year 1880, by the discovery near this place, of a volcanic 'neck' filled with decomposed basic rock bearing a striking resemblance to the matrix of the diamonds at Kimberley in South Africa. Foote[48] and Lake[49] investigated the occurrence. The so-called volcanic 'neck' was found by Lake to consist of highly altered basic rock quite different from the 'blue ground' of Kimberley. C. S. Pichamuthu[50] found that the rock is a typical tuff containing fragments of foreign rocks such as the Gooty granite, hornblend-schist and others. The absence of augite and olivine suggests that it may be of andesitic composition. The 'neck' was fully prospected by Mr. A. Copley on behalf of the Madras Syndicate in 1884, but the operations proved unsuccessful. Occasionally however, especially after a fall of rain, diamonds are found on the surface to the east of the village, but not in the neighbourhood of the 'neck'. It is said that a diamond obtained from here valued at £. 10,000, was in the possession of Mr. R. S. Orr of Madras.

Foote disbelieves the assertion of Chaper[51] who has recorded that the source of the diamond is in an epidote-bearing pegmatite intrusive into granite, a short distance east of Wajra Karur. Foote thinks that the diamonds are derived from the conglomerates of the Kurnool formations which probably extended into this area formerly.

Bellary.—Huvin Hadagalli (15° 1′ 30″ : 76 0′). About 3 miles to the south of the village, Foote[52] found some small pits and sorting platforms which may be the relics of old diamond workings. There is however, no record of any finds of diamonds in this locality.

Cuddapah.—Chennur (14 34′ : 78° 52′). An account of these mines is given by Gribble in the Cuddapah Manual.[53] Diamonds were formerly obtained from a bed of gravel lying at about 6 ft. below the surface, but the mines had been deserted since the beginning of the last century. An attempt made in 1869 to work the mines did not prove successful; though there is a tradition, mentioned by King[54] that two stones, eventually sold for £. 5,000 and £. 3,000 respectively, had come from this field.[55]

Kanuparti or Kondapeta (14° 33′ 30″ : 78° 52′ 30″), Woblapalli and other places in the Cuddapah district are known to have produced diamonds from gravels which were excavated and washed. The operations seem to have persisted until about the year 1840.

Godavari.—Bhadrachalam (17° 40′ : 80° 57′). There is a tradition that diamond pebbles are occasionally picked up in the bed of the Godavari river near Bhadrachalam, which is attested by Voysey[56] as well as Newbold[57].

Guntur.—Kollur (16° 43′ : 80° 5′) As noted by Ball[58], this is apparently the 'Colour' or 'Quolure' of Tavernier[59, 60]. Tavernier visited the mines in 1645 when some 60,000 persons are said to have been employed in the mining. The pits were shallow, generally 12 to 14 ft. deep, and the sandy

clay won was disintegrated, by being soaked with water, dried, pounded with wooden hammers and winnowed to obtain the stones in a clean condition.

It was in this place that the diamond called 'Great Moghul' was probably found. Mir Jumla presented it to the Emperor Shah Jehan in 1656. It originally weighed 900 *ratis* or 787·5 carats, but it was reduced to 280 carats when cut. In the opinion of Ball[61], who went into its history carefully, it was the same stone which after the loss of a part, found its way into England in 1849 as the Koh-i-Nur[62]. This diamond area seems to have been to a large extent exhausted by the year 1677[63].

Madagula (16° 30′ : 79° 38′). This is probably the Maddemurg mentioned in the Phil. Transactions, where also the method of searching for the stones is given. The area was very productive but unhealthy.

Malavaram (16° 36′ : 79 31′ 30″) or Damarapad. According to Ball[64], the mines here are probably those described by Tavernier, as being situated between Kollur and Ramulkota. The stones from this locality are said to have been brittle, which led to the closing up of the mines.

Another locality[65] in this district is Pulichinta on the right bank of the Kistna river below Kollur.

Kistna.—The diamond-bearing areas are on the left bank of the Kistna river between Bezwada and the district boundary with the Nizam's Dominions. Voysey[66] and the Kistna District Manual[67] give an account of the mines in this tract. The diamonds are obtained from recent gravels and alluvia whose original source is either the Kurnool conglomerates or the Golapalli sandstones of Gondwana age. The workings form three groups :—

(1) Golapalli (16° 43′ : 80° 58′). The operations here are described in the Kistna Manual[68]. Blanford[69] thought that the mines were abandoned prior to 1810 or so.

Malavilli also lies near the above locality and the workings nearby have been mentioned by Heyne[70], Anderson[71], Benza[72], Newbold[73] and King[74]. The diamonds have been won from the sandstones forming the hills north of the village and from the talus and gravels at the bottom of the hills.

(2) Partial (16° 39′ : 80° 28′) Atkur, Barthenipadu, Mugalur and Munalur The mines at Partial have been described by Scott[75], Macpherson[76], Voysey[77] and Walker[78]. The diamonds here were worked in a bed of gravel lying at a depth of 14 ft. to 30 ft. below the surface. The deposits appear to have been exhausted by the earlier part of the 19th century.

(3) Ustapalli (16 42′: 80° 13′) with Kodavatakallu. This area is to be found in the angle formed by the Kistna and Muniair rivers. The workings are of the same nature as those of Partial. It is said that in the early days the mines produced several bullock-loads of diamonds[80, 81] though obviously this is highly improbable.

Kurnool.—Numerous old workings are found scattered over this district. The Kurnool Manual[82] gives an account of the industry and of the mines. Though originally the Banganapalle stage of the Kurnool formations must have produced an appreciable quantity of diamonds, the production between 1909 and 1913 was only 38·36 carats (value £. 19). Since then no production has been recorded.

The following list of workings is taken from King[83]:—

Banganapalle (15° 19′ : 78° 17′). The quartzites which bear the name of the above town are exposed on the hills to the west of the town. The diamond-bearing layer consists of conglomerate and breccia which are found as layers 6 to 8 inches thick. Pits are first sunk to the pebbly layers and then galleries are driven so as to follow the layers. The diamonds found here are said to be of poor quality, small and full of

flaws. For earlier accounts reference may be made to the writings of Heyne[84], Voysey[85], Malcolmson[86] and Newbold[87].

Bannur, close to Gudipaud.

Baswapur (15° 24′ 30″ : 78° 41′ 30″) The occurrences cover an area of about 2 sq. miles and have been described by Newbold[88] and King[89]. Most of the workings are in alluvium though some are in the Banganapalle quartzites.

Byanpalli-Gurumankonda. Rock workings.

Coomroli, close to Gurumankonda. (Cummerwille of Tavernier[90]). Only small stones obtained.

Deomurru (15° 49′ 30″ : 78° 11′).

Devanur (15° 43′ 30″ : 78° 19′).

Dhoni (15° 23′ 30″ : 77° 56′). Old alluvial workings are mentioned by Newbold[91]. In Tavernier's account this place is mentioned as having yielded stones of good shape and size, but rather poor in quality.

Gaserpalli, close to Baswapur. Produces stones similar to those at Dhoni.

Gudipaud (15° 44′ : 78° 18′).

Gurumankonda (Guttimanikonda, 15° 32′ : 78° 14′). Old rock workings.

Kannamadakalu (15° 42′ : 78° 15′). Old alluvial workings.

Lanjapolur (15° 45′ 30″ : 78° 4′). Stones of good shape and quality[90].

Munimadagu (15° 16′ : 78° 2′) with Madavaram. The old workings here have been described by Newbold[92] and King[93]. The workings are found in Banganapalle conglomerates and no systematic mining has been done; and no production has been recorded since 1813[94]. It is said that

since the beginning of the 19th century to about 1813, only seven stones weighing more than a pagoda (about 16 carats) were produced here, with a small production of smaller stones[95].

Muravakonda (16° 1′ : 78° 19′). In the bed of the Kistna river at this place, diamonds are sometimes found.

Oruvakal (Voravakollu, 15° 41′ : 78° 14′). Small stones have been won from here.

Panchalingala (15° 52′ : 78° 5′).
Polur (15° 32′ : 78° 29′ 30″).
Pyapalli (15° 14′ : 77° 48′).
Ramulkota (15° 34′ : 78° 3′ 30″). According to Ball this is probably Tavernier's Raolconda. Diamonds are found here in sand and clay, filling joints and cracks in the rocks. The stones are small but of good quality. In 1840, when Newbold[96] visited this locality, there were workings in the debris at the foot of the hills, but old workings could be seen in the solid rock. King[97] has also described this occurrence.

Saitankota and Tandrapad (15° 51′ : 78° 7′) have been mentioned by Newbold[98].

Timapuram (15° 32′ : 78° 7′). Rock workings still worked in 1872.

Virayapalle. Mr. A. Ghose conducted some quantitative tests on a bed of conglomerate varying from 3 ins. to 2 ft. in thickness which gave a yield of 1/5 to 1/2 carat per 16 cub. ft. Most of the diamonds obtained were perfect crystals of fine quality and free from flaws[99].

Yembye (15° 33′ 30″ : 78° 10′ 30″). Old rock workings.

GARNET.

Kistna.—Kondapalli (16° 37′ : 80° 36′). Excellent transparent crystals of garnet are found here and also near

Bezwada along the banks of the Kistna river[100]. These are derived from garnet-bearing hornblende gneisses in the area, according to King[101, 102]. The Kondapalli garnets have been worked for a long time.

Nellore.—The red garnets of this district which are weathered out of the schistose rocks are collected from stream sands and are used as abrasive. Though excellent crystals are often got, they are semi-opaque and are of no use as gems in most cases.

CORDIERITE.

Vizagapatām.—Some of the metamorphic rocks of the hill tracts of this district contain small crystals of cordierite[103], which may be useful as gems.

GEM-STONES—OPAL, QUARTZ and ROSE QUARTZ.

Vizagapatam.—Fermor[104] states that opal is found replacing the felspathic portion of 'Kodurite' rock at Kodur (18° 16′ 30″ : 83° 36′ 30″), Kotakarra (18° 22′ 30″ : 83° 33′) and other places. Veins of rose-quartz are found in lithomargic rock at Kodur. Rather small crystals are found at Sadanandapuram (18° 14′ : 83° 37′).

Godavari.—According to Campbell[105], rock crystal used to be collected from amidst the sands of the Godavari river at Rajahmundry. The finds are apparently very rare now-a-days.

GOLD.

Anantapur.—A belt of Dharwar schists traverses this district and it contains several quartz reefs some of which are auriferous. The neighbourhood of Ramagiri (14° 18′ 30″ : 77° 33′) shows old workings.

The Anantapur Gold Field Ltd., started work in 1905 and became subsequently the North Anantapur Gold Mines Ltd.,

while another company the Jibutil Gold Mines of Anantapur Ltd., was also formed. The North Anantapur Gold Mines Ltd., did considerable work but closed down in 1925, while the Jibutil Gold Mines ceased operations in 1924.

Bellary.—Jajkul Gudda (14° 51′ : 76° 6′ 30″). The streams draining the Jajkul Gudda, which is situated about 6 miles to the E. N. E. of Harappanahalli, show the presence of gold[106]. Of these, the most important, as mentioned by Foote are the Konganahosur on the east; a small stream W. by. N. of Chiggateru; and another stream near Changalu to the west of the hill. According to Maclaren[107] exhaustive trials in the Konganahosur stream gave very poor values in gold.

GRAPHITE.

Godavari.—Graphite occurs as pockets and veins amidst the Khondalites into which are intruded pegmatite veins in the Bhadrachalam taluq at Pedakonda (17° 33′ 30″ : 81° 28′ 30″), Pulikonda[108] (17° 33′ : 81° 26′), Sutrukonda and Rachakonda (17° 33′ : 81° 25′)[109]. It has also been recorded near Velogapalli and Yerrametla in the Chodavaram Division and at Gullapudi in the Polavaram Division. A small production of about 140 tons has been recorded from the Bhadrachalam occurrences between 1904 and 1908.

Kistna.—King discovered the presence of graphite in quartzitic rock in the neighbourhood of Bezwada[110, 111]

Vizagapatam.—Graphite is frequently found as a constituent of the rocks along the eastern border of the hills, generally in the Khondalites and possibly in the gneissic rocks. King[112] noted its occurrence in Salur (18° 31′ : 33° 16′) and Carmichael[113] near Kasipuram (18° 13′ : 83° 11′).

This district produced 259 tons of graphite in 1904 and 54 tons in 1911.

GYPSUM.

Nellore.—Crystals of selenite occur fairly abundantly in the marine clays at Santaravur (15° 48′ 30″ : 80° 19′) on the Buckingham Canal[114]. The *Gypsum* is fairly large and comparatively pure crystals.

IRON.

Bellary.—Iron sands and lateritic ores were used by indigenous smelters in many places in the district and formerly the annual production from this district amounted to about 600 tons. Bands of siliceous haematite[115] occur in the Sandur hills, near Bellary and on the Mallapan Gudda (14° 55′ : 76° 2′). Apparently good ore occurs in a ridge near Kammakaravu (15° 1′ : 76° 40′ 30″). The softer ores occurring near Kannevihalli (15° 3′ : 76° 34′) have been much used by the indigenous industry.

Cuddapah.—Haematitic bands found amidst the Cuddapah formations have been worked near Yerraguntalakota (13° 58′ : 79° 20′) and Chintakunta (13° 44′ : 79° 14′). King[116] and Gribble[117] have given accounts of the industry in this district.

Godavari.—The neighbourhood of Polavaram (17° 15′ : 81° 42′) shows highly quartzose metamorphic rocks containing magnetite, according to Blandford[118]. Nodular concretions of brown iron ore occur in the different sandstone groups of this district, especially in the western part.

Kistna.—As in the Godavari district, here also ironstone occurs in the sandstone formations[119]. Iron was formerly manufactured in indigenous furnaces in many places in the district. Heyne[120] and others have given an account of the iron smelting in these areas.

Kurnool.—King[121] says that both the Cuddapah and Kurnool systems of this district contain iron ores, but it was worked mainly in the Cuddapahs. In the Gunigal ridge the ore is found filling fault planes. There are also bands of

ferruginous quartzites near about Nandyal (15° 29′ : 78° 40′), from which the ore has been won and smelted. The smelting process has been described by Wall[122].

Nellore.—In this district there are two groups of deposits[123], one near Ongole and the other near Gundlakamma. Some bands of ore are found in the Konijedu hill and Parnameta hill near Ongole, the upper bands being apparently the richest. In the latter area the ore occurs as bed-like lenses near Burapalle (15° 41′ : 80° 2′ 30″), Manikesavaram (15° 45′ 30″ : 80° 1′), Singaraikonda (15° 52′ : 80° 2′) and Vemparala (15° 54′ : 80° 0′). Siliceous haematite also occurs in the valley of the Swarnamukhi river[124] between Ircola (13° 48′ 30″ : 80° 0′) and Tresalmare (13° 51′ 30″ : 79° 56′). The Nellore Manual gives a list of localities where smelting was formerly carried on[125].

Vizagapatam.—The schistose rocks contain, in places, bands rich in iron ore[126]; for instance magnetite-quartz-schist occurs near Modopodor (18° 46′ 30″ : 82° 23′). Limonite is found in several places but not in large quantity.

Brown haematite[127] found near Chitra (19° 4′ : 82° 30′) has been worked for smelting iron. Iron ore, probably limonitic has been mined near Narainapatam (18° 52′ 30″ : 83° 14′)[128]. Formerly excellent steel used to be made at Madgul (18° 2′ : 82° 37′) and other places, and an idea of the iron industry of this region can be gained from a paper by Carmichael[129].

KAOLIN.

Godavari.—According to Benza[130], pockets of Kaolinic clay occur in the Godavari alluvium near Rajahmundry. Formerly this was used in the manufacture of high grade pottery which won fame.

Vizagapatam.—Near Vizianagaram, deposits of white clay are found. These are due to the alteration of the felspar of the gneisses[131].

A report has been issued by the Department of Industries, Madras, a few years ago on the resources of kaolin and related clays in the coastal districts to the north of Madras.

LEAD AND SILVER.

Cuddapah.—Jangamarajapalli (14° 46′ : 78° 57′). There is evidence of considerable former mining activity in this area, in the large number of old pits (about fifty in number). The ore is found in limestone either as veins or as pockets in cavities which are lined with quartz and iron oxide. The veins are said to be about 1 to 1½ inches in thickness. Newbold[132] described the occurrence in 1842, while Wall[133] in 1858 traced the veins over a distance of some 4 miles. King[134] states that the ore is found with the quartz which impregnates and veins the limestone of the Cumbum stage of the Cuddapahs. Some ore is also found in the quartzites to the south of the above occurrence. The samples collected by Wall assayed 66 to 69% lead, while one assayed by Mallet[135] contained 78% lead and 22 oz. 7 dwt. of silver per ton of lead content.

Lankamalai (14° 40′ : 78° 58′ 30″). Wall[136] states that the first occurrence probably continues to the south into the Lankamalai hills east of Nandialampet. To the south-east of Nagasanipalli (16° 42′ : 78° 52′) there is a rich vein exposed which occurs in two portions each of which is 4 to 5 inches in thickness, and yields about 18 cwt. of dressed ore per yard length of the ore-body. Further to the south is seen a quartz vein in the galena which crosses the Pennair River near Kottur (14° 36′ : 78° 48′). The Nagasanipalli ore yielded 70 to 76 per cent. lead on assay[137].

Guntur.—Karampudi (16° 26′ : 79° 47′). At the north-eastern end of the Wamiconda range above this village, lead ore occurs in the limestones forming part of the Cumbum stage[138].

Kurnool.—Basavapuram (15° 24′ 30″ : 78° 41′ 30″). The ore here is found in quartz veins occurring in slates and schists, associated with barytes gange. This occurrence was described by Newbold[139] and by Wall[140], who conducted prospecting operations. According to wall, galena is disseminated in a siliceous matrix which occurs as veins traversing granitic rocks. In some places the ore body is quite rich, and samples yielded 12 to 14 oz. of silver per ton of lead content[141].

LITHOGRAPHIC STONE.

Kurnool, Guntur and Kistna.—The Nerji limestone of the Kurnool system contains excellent lithographic stone[142]. The best localities are considered to be the Tungabhadra Valley in Kurnool; Dachapalli (16° 33′ : 79° 48′) in Guntur; Jaggayyapet or Batavole (16° 53′ 30″ : 80° 9′) in Kistna. Similar stone is also found at Chintapalli (16° 42′ : 80° 12′), on the River Kistna[143].

MANGANESE.

Bellary.—Teligi Hill (14° 39′ : 75° 57′). This is on the Dharwar-Shimoga band of Dharwarian rocks. Nodular pyrolusite and limonite is said to occur on the westerly spurs of this hill[144].

Sandur State.—The now well-known manganese deposits here were first mentioned by Newbold[145] and later by Foote[146]. Later prospecting in these hills by A. Ghose and others has revealed the existence of large ore-bodies of great economic importance. Descriptions have been given by Ghose[147], Ahlers[148] and Fermor[149].

The local geology of the hills shows that they are composed of schists, phyllites and banded haematite-quartzites with which are intercalated igneous sills. In structure it is a synclinal trough with its major axis N.W—S.E. The ore is associated with the phyllitic member in which it appears to be a replacement product. The ore in a large measure preserves and conforms to the lamination of the phyllite. The crest and western flank of syncline are the richest in ore, and the

replacement has occurred to an average depth of a little less than 100 ft. though in places much more. The ore is classified as 'lateritoid ore' by Fermor, and the passage of the mineralised phyillite downward into lithomargic material supports this view. The tops of the hills are usually marked by a thick crust or layer of ferruginous laterite. Ghose has put forward the view that the ore is an ancient marine sedimentary deposit but there seems to be little evidence in support of this.

The ore consists mainly of psilomelane and wad. Pyrolusite and manganite are more or less confined to cavities in the ore, while braunite and hollandite are quite subordinate and sporadic in occurrence. Though of rather low grade, and containing much iron, the ore is particularly poor in silica and phosphorus. The average analysis of 4 samples gives :—Mn. 45·05; Fe. 12·33; Silica 0·89 and P. 0·011 per cent. The quantity of ore in eleven deposits on the Kammat Haruvu plateau has been estimated at 1·3 million tons by Ghose, while Fermor's estimate of the quantity (including ferruginous manganese ore) in the Sandur Hills is 10 million tons.

At least a hundred separate deposits occur between the Kammat Haruvu to near Ramandrug. They have been divided into ten groups as shown below :—

Group.		No. of Deposits.
I. Kammat Haruvu	...	28.
II. Hanumanthana Haruvu	...	4.
III. Tonashigri Forest	...	6.
IV. Mannal Haruvu	...	10.
V. Kumaraswami	...	8.
VI. Subrayanhalli Range	...	8.
VII. Tumbaragaddi Forest	...	3.
VIII. Kanevihalli Range	...	11.
IX. Ramandrug Range	...	23.
X. Timmappa Gudda	...	1.

These deposits have been worked by the General Sandur Mining Co. The total production from 1905 to 1914 amounted to 418·424 tons of ore. During the War work was interrupted because of difficulties connected with transport, freight and marketing, but was resumed in 1921, since when a total of 1526·169 tons have been won to the end of 1933. Kammat Haruvu is now the chief producing area.

Kurnool.—Manganese ore is reported to occur at Rudravaram (15° 14′ : 78° 40′), Nandavaram (15° 22′: 78° 20′), Banganapalli (15° 19′ : 78° 35′) and Nagireddypalli (15° 9′ : 78° 35′).[150-151]

Vizagapatam.—The existence of manganese ore in this district seems to have been first noted in 1852[152] and two tons of the ore were exhibited in the Madras Exhibition of 1857[153]. Commercial exploitation began in 1892, and indeed it marked the entry of India into the world markets as a producer of manganese ore.

The ore occurs in association with the so-called 'Kodurite' in which are included a series of miscellaneous crystalline rocks all containing a high percentage of manganese. The rocks contain mainly a manganese-iron garnet, manganese pyroxenes, apatite and feldspar. They have been formed by the mixing of igneous rocks with original manganiferous sediments and have since been secondarily altered to lithomargic material in which the ore bodies are found. The ore bodies are irregular in shape and size and may or may not show any definite structure. The ore is considered to be a product of replacement of the ' Kodurite '.

The largest ore-body is that of Garbham which is 1,600 ft. long and 167 ft. thick at the maximum, about 100 ft. of thickness being ore and the remainder lithomarge. At Kodur there is a series of deposits in lithomarge.

The ores are composed mainly of psilomelane while pyrolusite, braunite and mangan-magnetite are subordinate,

and belong mainly to the second or third grade, ranging into ferruginous manganese ores. Because of the presence of much apatite in the original rock, the ore is highly phosphatic, and iron is high while silica is low. The average analysis is : Mn. 47·11 ; Fe. 9·70 ; Silica. 3·15 and P. 0·191 per cent.

Full descriptions of the geology of the ore-bodies have been given by Fermor[154], in his monograph, and Turner[155] has described one of the deposits.

The main deposits occur at:—

Kodur	(18° 16′ 30″ :	83° 36′). Devda not far from Kodur.
Sivaram	(18° 16′ :	83° 39′).
Perapi	(18° 16′ :	83° 41′).
Govindapuram	(18° 15′ :	83° 45′).
Garbham	(18° 22′ :	83° 31′).
Kotakarra	(18° 22′ :	83° 32′).
Gadasam	(18° 20′ :	83° 28′).
Avagudem	(18° 21′ :	83° 36′).
Chipurupalli	(18° 24′ :	83° 41′).
Perumali	(18° 26′ :	83° 38′).
Ramabhadrapuram	(18° 30′ :	83° 20′).
Taduru	(18° 25′ :	83° 16′).
Chintavalasa	(18° 25′ :	83° 20′).

There are also several other places of less importance.

MICA.

Nellore.—The first mine to be opened in this district was at Inikurti in 1889. Great activity was evinced in the acquisition of new properties in this district between 1904 and 1914, when over 160 leases were taken up.

The geology of the area has been described by T. L. Walker[156] and the deposits have been described by Thompson[157], Krishnaiya[158] and Dixon[159]. There is also a special monograph on Indian Mica deposits by T. H. Holland[160]. Special reports on the mining questions concerned with the

area, have been made at different times by the officers of the Geological Survey of India, *viz.*, G. H. Tipper, G. V. Hobson and P. K. Ghosh. These reports have been published by the Government of Madas.

Gneisses and schists occupy the plains of Nellore lying to the east of the Velikonda range. They are intruded by granite rocks and associated pegmatites and veins of quartz. The mica occurs in close association with pegmatite. There are four main areas according to Krishnaiya[160], *viz.*, around Gudur, Rapur, Atmakur and Kavali. In the Gudur area there is a vein of mica pegmatite which is worked at Mangalpur. The Rapur zone contains many important mines of which Pallimitta and Tellabodu near Saidapuram (14° 11′ : 79° 48′), Kalichedu (14° 18′ : 79° 48′), Inikurti (14° 20′ 30″ : 79° 46′ 30″) and Lakshminarayana near Chaganam (14° 12′ : 79° 44′), are on a large lens-like boss of pegmatite, while Sankara near Gridalur (14° 16′ : 79° 50′) lies on a thick lens 100 ft. long and 40 ft. wide. Rappala Dibba is situated on a vein 150 ft. long and 40 ft. wide in the Atmakur area. Some of the mines have reached to nearly 600 ft. depth. The greater part of the mica of the district shows a slight greenish tinge which is said to be due to the presence of chromium. But the much prized ruby-mica of a reddish tinge is also found. There is also a good lot of iron staining in the mica. The output has varied greatly from year to year between 5,000 and 25,000 cwts., and in recent years, has been about 8,000 cwts.

Vizagapatam :—Phlogopite exhibiting asterism and of a size 4 to 5 inches in diameter is found in the Waltair estate.

MINERAL WATERS.

A few mineral water springs have been noted in the Andhra Desa. Near Ramandrug in Bellary[160A] are carbonated and chalybeate springs with traces of lime. In the bed of the Godavari River at Gandala[160B] (17° 39′ : 81° 0′) is a spring emitting sulphuretted hydrogen and containing small amounts

of sodium chloride and sulphate, the temperature of the water being 149°F. Near Kalva (15° 37′ : 78° 16′) in Kurnool[160c] there are three warm springs (temperature 90°F), containing calcium carbonate, which leaves calcareous tufa on evaporation. At Lanjabanda there is an alkaline warm spring containing lime. There are also several warm springs near Mahanandi[160D] (15° 29′ : 78° 41′).

MONAZITE.

Vizagapatam.—The beach sands at Waltair[161] contain small quantities of monazite and certain other heavy minerals derived from the gneisses of the hills and plains of the district. No commercially workable deposits have been located.

OCHRE.

Bellary.—Associated with a bed of iron ore about 1½ miles west of Kumaraswami temple (15° 1′ : 76° 37′) are thin argillite bands of red and yellow colour which have been locally used as a paint material[162].

In the Ramandrug area there are large quantities of soft red haematites and dark brown wads which seem suitable for the manufacture of red and brown paints.

PHOSPHATES.

Nellore.—Apatite is a constituent of the granite and pegmatites of the mica-belt. Small quantities can be won as a by-product of mica-mining [163].

Vizagapatam.—The Kodurites of Vizagapatam manganese deposits contain much apatite as an occasional constituent. It is said to be abundant in the lithomarge of the mines at Garbham (18° 22′ : 83° 31′) Ramabhadrapuram (83° 30′ : 83° 20′), Devada (18° 15′ : 83° 38′) and other places [164].

Vizianagaram.—A lenticular mass of apatite-bearing rock occurs on a hill near Sitaramapuram[165] 25 miles north of Vizianagaram and near the Vizianagaram—Anantagiri road.

The apatite veins are up to 3 ft. in width. A sample from here analysed 40·5 per cent, phosphoric acid, 53·76 per cent. lime, 1·52 per cent. silica, 3·47 per cent. fluorine, 0·55 per cent. chlorine and 0·22 per cent. water. It has been estimated that the above area contains not less than 5,000 tons within a depth of 30 feet.

RARE MINERALS.

Nellore.—Columbite occurs in small quantities in the mica-pegmatites near Chaganam[166] (14° 13′ : 79° 44′ 39″).

Samarskite.—The mineral was originally discovered in the area by P. N. Bose. It occurs in the Sankara mine near Gridalur, amidst the felspar of the pegmatite as grains and masses up to 200 lbs. in weight. It has a specific gravity of 5·74 and is radio-active. G. H. Tipper[167] has described the occurrence of the mineral.

STEATITE AND POTSTONE.

Anantapur.— Good compact potstone, free from grit is obtained from the neighbourhood of Narjampalli (14° 33′ : 78° 5′)[168].

Bellary.—Bellary is rich in steatite deposits according to Foote[169]. Nilgunda Hill (14° 44′ : 75° 57′), Angur (14° 57′ 30″ : 75° 49′), Harappanahalli (14° 48′ : 76° 2′ 30″), Arsapur Hill (14° 40′ : 76° 5′) and Somalapuram (15° 2′ : 76° 34′) are the localities where the deposits appear to be good and have been worked formerly.

Kurnool.—According to Newbold [170], steatite, of excellent quality occurs near Dhone (15° 23′ 30″ : 77° 56′). King[171] has described the occurrence of thin layers (2 to 4 inches in thickness) of very good quality steatite or talc found intercalated with the shales of the Papaghni Group near Maddavaram (15° 30′ : 78° 9′). Another good deposit exists at Musalacheruvu[172] near Betamcherla (15° 27′ : 78° 13′) which was worked by Mr. A. Ghose for some time. Near Pendakallu

15° 22′ 30″ : 77° 41′) excellent crystalline green steatite occurs, the deposit covering an area of 17 acres[173]. A few other areas are also mentioned in the Kurnool Manual[174].

Nellore.—Near Jogipalli[175] (14° 13′ 30″ : 79° 47′ 30″) occur talcose schists which have been used for making cooking utensils, and small objects. Similar schists also occur near Saidapuram (14° 11′ : 79° 48′).

Vizagapatam.—The neighbourhood of the town of Jeypore shows deposits of grey steatite which is made into vessels, figures etc.[176]. It is worked near Ontagaon, Modpodor (18° 46′ 30″ : 82° 23′) and near Kolar (18° 42′ : 82° 26′) on the Malkongiri road.

ZINC.

Kurnool.—A specimen of smithsonite associated with barytes, blende and galena, has been described by Mallet[177]. It probably came from the lead mines of Basvapuram.

PART II.

Bibliographical Index of Reported Occurrences.

ANTIMONY.

1. *Kelsall*, J. 1872—Manual of the Bellary District; (P. 93)

2. *Ball, Dr. V.*—Manual of the Economic Geology of India; (P. 164).

3. *Newbold, T. J.* 1839.—Some account, Historical, Geographical and Statistical, of the Ceded Districts. Mad. Journ. Lit. Sci; X; (P. 125).

4. *Carmichael, D. F.* 1869.—A Manual of the District of Vizagapatam, in the Presidency of Madras; (P 155).

5. *Ball, Dr. V.*—Manual of the Economic Geology of India; (P. 164).

6. *Balfour, E.* 1855.—*See* on the Iron Ores; the Manufacture of Iron and Steel, and the coals of the Madras Presidency (P. 238).

ASBESTOS.

7. *Coulson, A. L.* 1934.—Memoirs of the Geological Survey of India, Vol. LXIV, Part ii.

BARYTES.

8. *Jones, H. Cecil.* 1908.—Notes on Barytes occurring at Narravada, Nellore District. Rec. G. S. I. XXXVI (P. 233).

9. *Coulson, A. L.* 1933.—Memoirs of the Geological Survey of India, Vol. LXIV, Part i.

BAUXITE.

10. *Holland, Sir, T. H.* 1907.—Presidential address, Mining and Geological Institute of India (The relationship of Pure to Applied Science. The development of Indian Metalliferous Minerals) Trans. Min., Geol. Inst. Ind., II; (P. 31).

11. *Fox, C. S.*—In the General Report of the Geological Survey of India for 1930. Rec. G. S. I. LXV, P. 35 (1931).

BUILDING MATERIALS.

12 *Foote, R. B.* 1896.—The Geology of the Bellary district, Madras Presidency. Mem. G. S. I., XXV. (Pp. 199—205).

13. *King, W.* 1872.—On the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G. S. I., VIII, (pp. 70, 281).

13-A. *Gribble, G. D. B.* 1875.—A Manual of the District of Cuddapah in the Presidency of Madras. (P. 27, Chapter II, Geological notes by Dr. W. King).

14. *King, W.* 1872.—On the Cuddapah and Kurnool Formations in the Madras Presidency. Mem G. S. I., VIII, (P. 283) (Abst., Geol. Mag., Dec. 1, X.).

15. *Bezna, P. M.* 1837.—Notes, chiefly geological, of a Journey through the Northern Circars in the year 1835. Mad. Journ. Lit. Sci., V. (P. 54).

16. *Foote, R. B.* 1879.—On the Geological Structure of the Eastern Coast from Latitude 15° northwar to Masulipatam. Mem. G. S. I. XVI, (P. 106).

17. *Voysey, H. W.* 1833.—Report on the Geology of Hyderabad. Journ. A.S.B., II. (P. 402).

18. *King, W.* 1872.—On the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G. S. I. VIII. (P. 282).

19. *Mackenzie, G.* 1883.—A Manual of the Kistna district, in the Presidency of Madras (P. 243) (Chap. VII deals with the Geology).

20. *Gopalakrishnamah Chetty, N.* 1886.—A Manual of the Kurnool district in the Madras Presidency (P. 98) (Geology and Minerals, Chapters V and VI.)

21. *King, W.* 1872—On the Cuddapah and Kurnool Formations in the Madras Presidency *loc. cit.* (P. 166).

22. *Foote, R. B.* 1879—On the Geological Structure of the Eastern Coast from Latitude 15° northward to Masulipatam. Mem. G.S.I., XVI (P. 105).

23. *Walker, T. L.* 1900.—A Geological sketch of the Central portion of Jeypore Zemindari, Vizagapatam district. Gen. Rep. G.S.I. 1899—1900. (P. 175) (Abst., Geol. Centralbl., I, A.V. Krafft).

COAL.

23-A. *Blanford, W. T.* 1871.—Report on the progress and results of borings for coal in the Godavari valley near Dummagudem and Bhadrachalam. Rec. G.S.I. IV, pp. 59–66.

23-B. *Simpson, R. R.* 1913—The Coal-fields of India. Mem. G.S.I., XLI, pp. 96–97.

23-C. *Blanford, W. T.* 1871.—(Same reference as 23-A, p. 48.)

23-D. *King, W.* 1874.—Note on the progress of geological investigation in the Godavari district. Rec. G.S.I., VII, pp. 158–160.

23-E. *King, W.* 1882.—Record of borings for coal at Bedadanuru, Godavari district, in 1874. Rec. G.S.I., XV, pp. 202–207.

COPPER.

24. *Newbold, T. J.* 1839.—Some account, Historical, Geographical and Statistical of the Ceded Districts. Mad. Journ. Lit. Sci. X (P. 125).

Newbold, T. J. 1842.—Mineral Resources of Southern India, Journ. R. As. Soc., VII (P. 150).

Newbold, T. J. 1845.—Notes, chiefly geological, across the Peninsula of S. India, from Madras, Lat. N. 13° 5′ to Goa, Lat. N. 15° 30′, by the Baulpilly Pass and Ruins of Bijanugger. Journ. A. S. B., XIV (P. 514).

25. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 241).

26. *Foote, R. B.* 1896.—The Geology of the Bellary district, Madras Presidency. Mem. G.S.I., XXV. (P. 197) (Review, Geol. Mag., Dec. 4, VII).

27. *Foote, R. B.* 1896.—The Geology of the Bellary district, Madras Presidency (Pp. 172, 198).

28. *Newbold, T. J.* 1842.—Mineral Resources of S. India. Journ. R. As. Soc. VII. (P. 150).

29. *Foote, R. B* 1872.—*See* on the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G. S. I. VIII (P. 270).

30. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 240).

31. *Foote, R. B.* 1872—*See* on the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G. S. I. VIII. (P. 269).

32. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India; with journals of several tours through various parts of the Peninsula ; also, an account of Sumatra, in a series of letters (P. 108).

33. *Foote, R. B.* 1872.—*See* on the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G. S. I., VIII. (P. 268).

34. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 240).

35. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 241).

36. *Gopalakrishnamah Chetty, N.* 1886.—A Manual of the Kurnool District in the Madras Presidency (P. 96). (Geology and Minerals, Chapters V and VI).

37. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India, with journals of several tours through various parts of the Peninsula ; also, an account of Sumatra, in a series of letters (P. 108), London.

38. *Thomson, T.* 1813.—Analysis of a new species of Copper Ore (from Mysore) Phil. Trans., CIV, (Pp. 45–50).

39. *Calder, J.* 1829.—General observations on the Geology of India. As. Res. XVIII, Part 1, page 9.

Prinsep, J. 1835.—Analysis of copper ore from Nellore. Journ. A. S. B. IV, pp. 574–584.

Prinsep, J. 1836.—Analysis of Nellore copper ores. Mad. Journ. Lit. Sci. III, pp. 154–159.

Ouchterlony, J. 1842.—Mineralogical report on a portion of the districts of Nellore, etc. Cal. J. Nat. Hist. II, pp. 283–285.

Newbold, 1842.—Mineral Resources of Southern India. J. Roy. As. Soc., VII, p. 151.

Mallet, F. R. 1879—On Mysorin and atacamite from Nellore district. Rec. G. S. I. XII, pp. 166–172.

40. *Sen Gupta, K. K.* 1928.—On the Copper deposits in the neighbourhood of Garimanipenta, Nellore district. Q. J. Geol. Min. Met. Soc. India, I, pp. 157–162.

King, W. 1880.—The Gneiss and Transition Rocks and other Formations of the Nellore Portion of the Carnatic. Mem. G.S.I. XVI, p. 185.

41. *Foote, R. B.* 1879.—*See* On the Geological Structure of the Eastern Coast from Latitude 15° northward to Masulipatam. Mem. G. S. I. XVI (p. 103).

CORUNDUM.

42. *Holland, T. H.*—(Revision of V. Ball). 1898, *See* Manual of the Geology of India—Economic Geology Part I, Corundum.

43. *Balfour, E.* 1857.—On materials from the province of the Madras Presidency, suited for grinding, sharpening and polishing. Scl. Rec. Madras Govt. N. S. XXXIX, pp. 69–96.

GEM-STONES. AGATE-AMETHYST-APATITE.

44. *Benza, P. M.* 1837.—Notes, chiefly geological, of a journey through the Northern Circars in the year 1835. Mad. Journ. Lit. Sci. V. (P. 53).

45. *Newbold, T. J.* 1842.—Notes, principally geological, on the tract between Bijapur and Bellary. Journ. A. S. B. XI (p. 936).

46. *Fermor, L. L.* 1909.—The Manganese-ore Deposits of India. Mem. G.S.I. XXXVII, (pp. 206, 1073).

47. *Fermor, L. L.* 1909.—The Manganese-ore Deposits of India. Mem. G.S.I., *loc. cit.*, (Pp. 206).

GEM-STONES. DIAMOND.

48. *Foote, R. B.* 1886.—Notes on the Geology of parts of Bellary and Anantapur districts. Rec. G. S. I., XIX, (p. 109).

1889.—Notes on the Wajra Karur Diamonds and on M. Chaper's alleged discovery of diamonds in pegmatite near the place. Rec. G. S. I., XXII.

49. *Lake, P.* 1890.—The supposed Matrix of the Diamond at Wajra Karur, Madras. Rec. G. S. I., XXIII, 69–72.

50. *Pitchamuthu, C. S.* 1932.—A note on the tuff of Wajra Karur, Anantapur district. Proc. 19th Ind. Sc. Congress, Bangalore, (1932), (p. 375).

51. *Chaper, M.* (i) 1884.—De La Presence du diamant dans une pegmatite de l' Industan. C. R. Ac. Sc. XCVIII, 113–115; Ann. Chim. Phys., Ser. 6, II, 284–288.

(ii) 1884.—Sur une pegmatite a' diamant et a' corindon de L' Hindoustan. Bull. Soc. Franc. Min., VII, 47–49.

(iii) 1886.—Note Sur une pegmatite diamantifere de l' Hindoustan–Bull. Soc. Geol. France, Ser. 3, XIV, 330–345 Abst., New, Jahrb. f. Min. 1887, I, Ref. 66–67.

52. *Foote, R. B.* 1889.—Notes on the Wajra Karur Diamonds, and on M. Chaper's alleged discovery of diamonds in pegmatite near the place, Rec. G. S. I., XXII (p. 43).

53. *Gribble, J. D. B.* 1875.—A Manual of the District of Cuddapah in the Presidency of Madras (p. 24).

54. *King, W.* 1872.—On the Cuddapah and Kurnool Formations in the Madras Presidency. Mem. G.S.I. VIII (p. 266).

55. *Ball, Dr. V.*—Manual of the Economic Geology of India (p. 9).

56. *Voysey, H. W.* 1825.—On the Diamond Mines of Southern India. As. Res. XV (p. 127).

57. *Newbold, T. J.* 1842.—Mineral resources of Southern India. J. R. As. Soc. VII (p. 226).

58 *Ball, Dr. V.*—Manual of Economic Geology of India. (p. 24).

59. *Tavernier, Jean Baptiste*, 1684.—Collections of Travels through Turkey into Persia and the East Indies, giving an account of the present state of those countries, as also a full relation of the five years' wars between Aurang-Zebe and his brothers in their father's life-time, about the succession ; and a voyage made by the Great Mogul (Aurang-Zebe) with his Army from Delhi to Lahor, from Lahor to Bember from thence to the Kingdom of Kachemire, by the Moguls called the Paradise of the Indies (Vol. I, Part 2, page 137).

60. *Howard, H. Earl Marshal of England.* 1677.—*See* A description of the Diamond Mines, as it was presented... to the R. Society. Phil. Trans. (p. 908).

61. *Ball, Valentine.* 1889.—Travels in India of Jean Baptiste Tavernier, Baron of Aubonne. Translated from the original French edition of 1676. Vol. II (p. 431).

62. *Maskelyne, N. Story.* 1855.—*See* (Note on the History of the Koh-i-Noor Diamond) Proc. Ashm. Soc., III (pp. 59–63).

Maskelyne, N. Story. 1891.—*See* The Koh-i-Noor; a criticism. Nature, XLIV, pp. 555–559 ; XLV, pp. 5–7.

Ball, Valentine. 1890.—*See* The Great Mogul's Diamond and the Koh-i-Noor. Nature, XLIII, 103, and,

Ball, Valentine. 1891.—*See* The Koh-i-Noor; A reply. Nature, XLIV, pp. 592, 593; XLV (p. 126).

Beveridge, H. 1899—*See* Babar's Diamond. Was it the Koh i-Noor? As. Quart. Rev. Ser. 3, VII, 370–389.

63. *Howard, H. Earl Marshall of England.* 1677.—A description of the Diamond Mines, as it was presented..... to the R. Society, Phil. Trans. (p. 908).

64. *Ball, Valentine.* 1881.—A Manual of the Geology of India, Part III. Economic Geology (p. 16).

Ball, Valentine. 1889.—Travels in India of Jean Baptiste Tavernier, Baron of Aubonne. Translated from the original French edition of 1676. (Vol. II, p. 78).

65. *Voysey, H. W.* 1825.—Report on the Geology of Hyderabad. Journ. A.S.B. (P. 403).

66. *Voysey, H. W.* 1833.—On the Diamond Mines of South India. As. Res., XV, 120–128; Phil. Mag., LXVIII, 370–376; Froriep's Notizen, XVI, 129–136. (Abst. Edin. Journ. Sci., VI, (Pp.97–104).

67. *Mackenzie, G.* 1883.—A Manual of the Kistna District, in the Presidency of Madras (P. 244).

68. *Mackenzie, G.* 1833.—A Manual of the Kistna District, in the Presidency of Madras (P. 146)

69. *Blanford, W. T.* 1871.—Description of the Sandstones in the neighbourhood of the first barrier on the Godavari.....and Ellore. Rec. G.S.I. IV (P. 27).

70. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India; with journals of several tours through various parts of the Peninsula; also, an account of Sumatra in a series of letters (P. 92).

71. *Anderson, J.* 1820.—Account of the Strata at the Diamond Mines of Mallivully. Edin. Phil. Journ., III. (Pp. 72–73.)

72. *Benza, P. M.* 1837.—Notes, chiefly Geological, of a journey through the Northern Circars in the year 1835, Mad. Journ. Lit. Sci., V. (P. 47).

73. *Newbold, T. J.* 1844.—Notes, chiefly Geological, across the peninsula from Masulipatam to Goa, comprising remarks on the origin of the Regur and Laterite; occurrence of Manganese veins in the latter, and on certain traces of aqueous denudation on the surface of South India. Journ. A.S.B. XIII (P. 985).

74. *King W.* 1880.—The Upper Gondwanas and other Formations of the coastal region of the Godavari district. Mem. G.S.I., XVI, P. 253.

75. *Scott, W.* 1823.—An account of the Diamond Mines at Purtyall. As. Journ., XVI, (Pp. 228–230.)

76. *Macpherson, S. Charters.* 1833.—On the Geology of the Peninsula. As. Res., XVIII, P. 118.

77. *Voysey, H. W.* 1844.—Extracts from the late Dr. Voysey's Journals, when attached to the Trigonometrical Survey in Southern and Central India. Journ. A.S.B., XIII, (P. 291).

78. *Walker, A. M.* 1850—Statistical Report on the Northern and Eastern Districts, Soubah of Hyderabad. Mad. J. Lit. Sci., XVI, (P. 184).

79. *Ball, Dr. V.*—Manual of the Economic Geology of India, (P. 23).

80. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India; with Journals of several tours through various parts of the Peninsula; also, an account of Sumatra, in a series of Letters (P. 94).

81. *Ball, Dr. V.*—Manual of the Economic Geology of India, (P. 22).

82. *Gopalakistnamah Chetty, N.* 1886.—A Manual of the Kurnool district in the Presidency of Madras. (P. 94).

83. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G.S.I. VIII, (P. 106).

84. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India; with journals of several tours through various parts of the Peninsula; also, an account of Sumatra, in a series of letters. *loc. cit.* (P. 102).

85. *Voysey, H. W.* 1825.—On the Diamond Mines of Southern India. As. Res., XV, 120–128; Phil. Mag., LXVIII, 370–376; Froriep's Notizen, XVI, 129–136. (Abst., Edin.) Journ. Sci. VI, (Pp. 97–104).

86. *Malcolmson, J. G.* 1833.—Note on Saline Deposits in Hyderabad. Journ., A.S.B, II (P. 78).

87. *Newbold, T. J.* 1836.—A glance of the Banganapally Jaghir, taken while passing through that territory in March 1836. Mad. Journ. Lit. Sci. III, (P. 120).

88. *Newbold, T. J.* 1846.—Notes, chiefly Geological, from Koompta on the Western Coast (S. India) by the Devamunni and Nundi Cunnama Passes Easterly, to Cumbum, and thence Southerly to Chittoor; comprising a notice of the Diamond and Lead Excavations of Buswapur. Journ. A.S.B., XV. (P. 390).

89. *King, W.* 1866.—An account of parts of the Nullamullays, a range of mountains in the Kurnool district. Mad. Journ. Lit. Sci., Ser. 3, Pt. 2 (P. 71).

King, W. 1872.—On the Kadapah and Karnul Formations in the Madras Presidency, Mem. G.S.I., VIII. (P. 103).

90. *Howard, H. Earl Marshall of England.* 1677.—*See* A description of the Diamond Mines, as it was presented .....to the R. Society Phil. Trans. XII (P. 913).

91. *Newbold, T. J.* 1847.—Notes, chiefly Geological, from Gooty to Hyderabad, South India, comprising a brief notice of the old Diamond pits at Dhone. Journ. A.S.B. XVI, (P. 478).

92. *Newbold, T. J.* 1842.—Mineral Resources of Southern India. Journ. R. As. Soc. VII (P. 230).

93. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G.S.I., VIII (P. 103).

94. *Kelsall, J.* 1872.—Manual of the Bellary district, Madras. (P. 96). (Chapter VI, Geology and Mineralogy).

95. *Ball, Dr. V.* 1881.—Manual of the Economic Geology of India (P. 11).

96. *Newbold, T. J.* 1840. A cursory notice of the Gold Tract on the Kupputgode Range - Manganese Mines near Wodoorti, - and Flint excavations in the Southern Mahratta Country, the Corundum Pits of the Western part of Mysore, and the Diamond Mines of Kurnool. Mad. Journ. Lit. Sci. XI. (P. 47).

Newbold, T. J. 1842.—Mineral Resources of Southern India. Journ. R. As. Soc., VII. (P. 231).

97. *King, W.* 1872.—On the Kadapah and Kurnool Formations in the Madras Presidency. Mem. G.S.I., VIII. (P. 105).

98. *Newbold, T. J.* 1842.—Mineral Resources of South India. Journ. R. As. Soc. VII. (P. 232).

99. *Holland, Sir T. H.*; *Hayden, H. H.*; *and Fermor, L. L.*—1915. *See* Quinquennial Review of the Mineral productions of India. Revised for the years 1909 to 1913. Rec. G.S.I., XLVI, (P. 83), Also in subsequent quinquennial reviews of mineral production.

GEM—STONES—GARNET.

100. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India; with journals of several tours through various parts of the Peninsula; also, an account of Sumatra, in a series of letters (P. 252).

101. *King, W.* 1880.—The Upper Gondwanas and other Formations of the coastal region of the Godavari district. Mem. G.S.I., XVI (P. 264).

102. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 522).

GEM—STONES—CORDIERITE.

103. *Walker, T. L. and Collins, W. H.* 1907.—Petrological study of some rocks from the Hill Tracts, Vizagapatam district, Madras Presidency. Rec. G. S. I. XXXVI (P. 13).

GEM—STONES—OPAL.

104. *Fermor, L. L.* 1909.—The Manganese Ore Deposit of India. Mem. G.S.I., XXXVII (Pp. 212, 214).

ROCK—CRYSTAL AND ROSE—QUARTZ.

105. *Campbell, J.* 1842.—Notes on the Minerals of Salem District, (Madras). Cal. Journ. Nat. Hist. II (P. 282).

GOLD.

106. *Foote, R. B.* 1896.—The Geology of the Bellary District, Madras Presidency. Mem. G.S.I., XXVI. P. 196). (Review, Geol. Mag., Dec. 4, VII, pp. 77 - 79.)

107. *Maclaren, J. Malcolm.* 1906.—Notes on some Auriferous Tracts in Southern India. Rec. G.S.I. XXXIV. (P. 119).

GRAPHITE.

108. *Rowe, L.* 1901.—Graphite in India. Min. Journ., LXXI. (P. 1020.)

109. *Heron, A.M.* 1936.—General Report of the Geological Survey of India for 1935. Rec. G.S.I. LXXI (pp. 42–43.)

110. *King, W.* 1874.—Note of the Progress of Geological Investigation in the Godavari District, Madras Presidency. Rec. G.S.I., VII. (P. 160).

King, W. 1880—The Upper Gondwanas and other Formations of the Coastal Region of the Godavari district. Mem. G.S.I., XVI (P. 263).

111. *Ball, Dr. V.*—Manual of the Economic Geology of India (P. 53).

112. *King, W.* 1886.—Geological Sketch of the Vizagapatam district, Madras. Rec. G.S.I., XIX (P. 155).

113. *Carmichael, D. F.* 1869.—A Manual of the District of Vizagapatam in the Presidency of Madras (P. 154) (Vol. 1, Sec. IV, Geology, compiled from Dr. Benza's Notes in Mad. Journ. Lit. Sci. Vol. V.).

GYPSUM

114. *Foote, R. B.* 1879.—On the Geological Structure of the Eastern Coast from Latitude 15° northward to Masulipatam. Mem. G.S.I., XVI, (P. 93).

IRON

115. *Foote, R. B.* 1888.—The Dharwar System, the Chief Auriferous rock series in South India. Rec. G.S.I. XXI (P. 25).

Foote, R. B. 1896.—The Geology of the Bellary district, Madras Presidency. Mem. G.S.I., XXV, Chapter V.

116. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G.S.I. VIII (P. 280).

117. *Gribble, J. D. B.* 1875.—A Manual of the District of Cuddapah in the Presidency of Madras. (P. 26).

118. *Blanford, W. T.* 1871.—Description of the Sandstones in the neighbourhood of the first barrier on the Godavari, and in the country between the Godavari and Ellore. Rec. G.S.I. IV. (P. 114).

119. *King, W.* 1880—The Upper Gondwanas and other Formations of the Coastal Region of the Godavari district. Mem. G.S.I. XVI (P. 255).

120. *Heyne, B.* 1814.—Tracts, Historical and Statistical on India ; with journals of several tours through various parts of the Peninsula ; also, an account of Sumatra, in a series of letters (P. 218.)

Ball, V.—Manual of the Economic Geology of India (P. 358.)

121. *King, W.* 1872.— On the Kadapah and Karnul Formations in the Presidency of Madras. Mem. G.S.I, VIII (P. 277).

122. *Wall, P. W.* 1858.—On Iron making at Roodrar (Kurnool). Mad. Journ. Lit. Sci. N. S., IV, (pp. 299-304).

123. *Foote, R. B.* 1879.—On the Geological Structure of the Eastern Coast from Latitude 15° northward to Masulipatam. Mem. G.S.I. XVI (P. 17).

124. *King, W.* 1880.—The Gneiss and Transition Rocks and other Formations of the Nellore portions of the Carnatic. Mem. G.S.I. XVI (P. 142).

125. *Boswell, J. A. C.* 1873.—A Manual of the Nellore district in the Presidency of Madras (P. 63).

126. *Walker, T. L.* 1900.—A Geological Sketch of the Central Portion of Jeypore Zemindari, Vizagapatam district. Gen. Rep. G.S.I. 1899-1900 (P. 175).

127. *Ball, Valentine.* 1881.—A Manual of the Geology of India. Part III–Economic Geology (P. 360).

128. *Vertue, J.* 1859.—General description of the country between Parvatipore and Jeypore. Mad. Journ. Lit. Sci. N.S., V (P. 271).

129. *Carmichael, D.F.* 1869.—A Manual of the District of Vizagapatam, in the Presidency of Madras (P. 154).

KAOLIN.

130. *Benza, P. M.* 1837.—Note, chiefly geological, of a journey through the Northern Circars in the year 1835. Mad. Journ. Lit. Sci., V. (P. 54).

131. *King, W.* 1886.—Geological Sketch of the Vizagapatam district, Madras. Rec. G. S. I., XIX. (P. 156).

LEAD AND SILVER.

132. *Newbold, T. J.* 1842.—Mineral Resources of South India. Journ. R. As. Soc. VIII. (P. 215).

133. *Wall, P. W.* 1858.—Report on the Silver Lead Ores of Kurnool and other portions of the Ceded Districts, Mad. Journ. Lit. Sci., N. S. IV. (P. 295).

134. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G. S. I., VIII (P. 273).

135. *Ball, Dr. V.*—*See* Manual of the Economic Geology of India (P. 281).

136. *Wall, P. W.* 1858.—Report on the Lead Ores in the Cuddapah district. Mad Journ. Lit. Sci. N. S., IV-pp. 279–284.

137. *Ball, Dr. V.*—A Manual of the Economic Geology of India (P. 284).

138. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G.S.I. VIII (P. 276).

139. *Newbold, T. J.* 1846.—Notes, chiefly geological, from Koompta on the Western Coast. (S. India) by the Devamunni and Nundi Cunnama Passes, Easterly to Cumbum, and thence Southerly to Chittoor; comprising a notice of the Diamond and Lead Excavations of Buswapur. Journ. A.S.B., XV (P. 389).

140. *Wall, P. W.* 1858,—Report on the Silver Lead Ores, of the Kurnool District. Mad. Journ. Lit. Sci., N.S., IV, pp. 285 - 289.

Wall, P. W. 1858.—Report on the Silver Lead Ores of Kurnool and other portions of the Ceded Districts, Mad. Journ. Lit. Sci. N.S., IV (P. 290).

141. *Ball, Dr. V.* —Manual of the Economic Geology of India (P. 285).

LITHOGRAPHIC STONE.

142. *Balfour, E,* 1854.—On the Marbles of the Madras Presidency. Sel. Rec. Madras Govt., Ser. I, II, (P. 38).

143. *Benza, P. M.* 1837.—Notes, chiefly geological of a journey through the Northern Circars in the year 1835. Mad. Journ. Lit. Sci., V, (P. 45).

Ball, Dr. V.—Manual of the Economic Geology of India. (P. 557).

MANGANESE.

144. *Fermor, L. L.*—Manganese-Ore Deposits of India, Mem. G.S.I. XXXVII (P. 992).

145. *Newbold, T. J.* 1839.—Some account, Historical, Geographical and Statistical, of the Ceded Districts. Mad. Journ. Lit. Sci., X. (P. 125).

146. *Foote, R. B.* 1888.—The Dharwar System, the Chief Auriferous rock series in South India. Rec. G.S.I., XXI., (P. 26).

Foote, R. B. 1896.—The Geology of the Bellary district, Madras Presidency. Mem. G.S.I., XXV (P. 194).

147. *Ghose, A.* 1910.—Manganese - Ore Deposits of the Sandur State. Trans. Min. Geol. Inst. Ind. IV, pp. 155-294.

148. *Ahlers, R. O.* 1908.—A Manganese Deposit in Southern India. Trans. Inst. Min. Met., XVIII, pp. 133-152.

149. *Fermor, L. L.*—Manganese-Ore Deposits of India. Mem. G.S.I. XXXVII (P. 993).

150. *Gopalakrishnamah Chetty, N.*—A Manual of the Kurnool District in the Presidency of Madras. (P. 99).

151. *Fermor, L. L.*—Manganese-Ore Deposits of India. Mem. G.S.I. XXXVII (P. 1038).

152. *Scott, A. J.* 1852.—Analysis of Indian Ores of Manganese and of some Scottish Zeolites. Edin. N. Phil. Journ. LIII, (pp. 277–284).

Balfour, E. 1857.—Cyclopædia of India and of Eastern and Southern Asia, Commercial, Industrial and Scientific products of the mineral, vegetable and animal kingdom, useful arts and manufactures. 1st Edn. (P. 1183).

153. *King, W.* 1886.—Geological Sketch of the Vizagapatam District, Madras. Rec. G. S. I., XIX (P. 155).

154. *Fermor, L. L.*—Manganese-Ore Deposits of India. Mem. G.S.I. XXXVII (pp. 243, 1045 etc.)

155. *Turner, H. G.* 1896.—(On the Manganese-Ore of Vizagapatam district (Journ, I. S. Inst., L. (155–160) Imp. Inst. Journ. III, 188–189 (Abst. Eng. Min. Journ., LXIII, 513–514).

MICA.

156. *Holland, Sir T. H.* 1902.—*See* The Mica Deposits of India. Mem. G.S.I., XXXIV, p. 59.

157. *Thompson, R. W.* 1898.—Mica Mining in the District of Nellore, India. Journ. Soc. Arts., XLVI, 671–673. (Abst., Coll. Guard., LXXV, 1134).

158. *Krishnaiya, A.* 1910.—Mica in Nellore, Trans. Min. Geol. Inst. India., V, pp. 181–203.

159. *Dixon, A. F.* 1913.—The Indian Mica Industry. Trans. Amer. Inst. Min. Eng. XLV, pp. 94–112; Min. Journ., LI, pp. 609—612.

160. *Holland, Sir T. H.*—Mica Deposits of India. *loc. cit.* (P. 58).

MINERAL WATERS

160-A. *Mayne, J.* 1855.—Quantitative Analysis of the Spring Water of Ramandroog. Ind. Ann. Med. Sci. II, Pp. 229–242.

160-B. *Voysey H. W.* 1833.—Report on the Geology of Hyderabad. Journ. A.S.B., II. (Pp. 396).

160-C. *Newbold, T. J.* 1848.—On the Thermal Springing of Calwa and Mahanandi in the Kurnool Province. Mad. Journ. Lit. Sci., XV, Pp. 160–162.

160-D. *Gopalakristnamah Chetty, N.* 1886.—A Manual of the Kurnool district in the Presidency of Madras (P. 11).

MONAZITE

161. *Tipper, G. H.* 1914.—The Monazite sands of Travancore. Rec. G.S.I., XLIV. (P. 195).

OCHRE

162. *Foote, R. B.* 1896.—The Geology of the Bellary district, Madras Presidency. Mem. G.S.I., XXV, (P. 193).

PHOSPHATES—LIME

163. *Holland, Sir T. H., Hayden, H. H., and Fermor, L. L.* 1915.—Quinquennial Review of the Mineral Production of India. Revised for the years 1909 to 1913. Rec. G.S.I. XLVI, (P. 283).

164. *Fermor, L. L.* 1909.—The Manganese-Ore Deposits of India. Mem. G.S.I., XXXVII, (P. 251).

165. *Krishnan, M. S.* 1936.—Quinquennial Review of Mineral Production of India, 1929—33. (Chapter on Phosphates). Rec. G.S.I., LXX. (P. 422).

RARE MINERALS—COLUMBITE AND TANTALITE

166. *Griesback, C. L.* 1899.—General Report on the work carried on by the Geological Survey of India, 1898–1899. (P. 9), Calcutta.

SAMARSKITE

167. *Tipper, G. H.* 1910.—Notes on the occurrence of Samarskite in South India. Rec. G.S.I., XXXVIII, P. 342 (Abst., Zeits. f. Kryst., L. 269, H. L. Bowman).

Tipper, G. H. 1911 –Note on the occurrence of Samarskite and other minerals in the Nellore district, Madras Presidency. Rec. G.S.I., XLI, Pp. 210–213 (Abst. Bull. Imp. Inst., X, 482–483 ; Trans. N. E. Inst. Min. Eng. LXII, App. 21–22, A.P.A.S., Journ. Chem. Soc., C. Pt. 2, 1105–1106, L.J.S.).

STEATITE AND POTSTONE

168. *Mallet, F. R.* 1889.—Notes on Indian Steatite. Rec. G.S.I., XXII, (P. 62).

169. *Foote, R. B.* 1896.—The Geology of the Bellary District, Madras Presidency. Mem. G.S.I. XXV, (P. 203).

170. *Newbold, T. J.* 1847.—Note, chiefly Geological, from Gooty to Hyderabad, South India, comprising a brief notice of the old Diamond Pits at Dhone. Journ. A S.B. XVI, (P. 478).

171. *King, W.* 1872.—On the Kadapah and Karnul Formations in the Madras Presidency. Mem. G.S.I. VIII. (P. 166).

172. *Holland, Sir T. H., Hayden, H. H., and Fermor, L. L.* 1915.—Quinquennial Review of the Mineral Productions of India, for the years 1909 to 1913. Rec. G.S.I., XLVI, (P. 292).

173. *Mallet, F. R.* 1889.—Note on Indian Steatite. Rec. G.S.I. XXII, (P. 62).

174. *Gopalakristnamah Chetty, N.* 1886.—A Manual of the Kurnool District in the Presidency of Madras (P. 97).

175. *King, W.* 1880—The Gneiss and Transition Rocks and other formations of the Nellore portion of the Carnatic. Mem. G.S.I., XVI (P. 163).

176. *Walker, T. L.* 1900.—A Geological Sketch of the Central portion of Jeypore Zemindari, Vizagapatam district. Gen. Rep. G.S.I., 1899–1900 (P. 168).

ZINC.

177. *Mallet, F. R.* 1881.—On the occurrence of Zinc Ore (Smithsonite and Blende) with Barytes in the Karnul District, Madras. Rec. G S.I, XIV, (P. 196).

Mallet, F. R. 1881.—On Turgite from the neighbourhood of Juggiapett, Kistna District, and on Zinc Carbonate from Kurnul, Madras. Rec. G.S.I., XIV, (Pp. 304-305).

CHAPTER IV.

PRODUCTION FIGURES.

Note.—The figures given in this Chapter are by no means exhaustive, but are intended to serve as a practical index to the actual possibilities of mining the various minerals available in the Andhra Desa. With a view to convey to the readers the economic possibilities of the minerals found in the area, short paragraphs have been added detailing the general uses to which each of the minerals can be put.

Copper.

The copper ore in the Nellore district has been worked from time immemorial. Even though occurrence of copper has been reported extensively in the Andhra area and old workings dating to protohistoric times exist, the only production figures we have in recent years are from Nellore, where in the neighbourhood of Garimanipenta, about 14 tons of ore was produced in 1926, and 365 tons in 1932. This was purely from the surface. The Company which has leased the area, has recently conducted prospecting operations by geophysical methods but the results pertaining to the extension of ores at depth are not known.

Copper is one of the most useful elements in the industries and arts. It is of prime importance in the manufacture of conducting wires for electrical purposes and it is possible to develop this industry in our area, should adequate supplies of ore be proved to exist. Many important alloys consist of copper and other metals *e.g.*, brass, is made of copper and zinc. As zinc has also been located in Kurnool District, it should be possible to sponsor local manufacture of brass for which there is so much demand. Gun-metal and bell-metal are alloys of copper and tin.

Diamonds.

It was already mentioned that Koh-i-Noor has been traced to have come from the "Golconda Mines." The Regent Pitt diamond which adorned the sword worn by Napoleon, is also known to have come from Kistna basin. Though no official returns are available about the production, it is known definitely that round about Wajra

Karur in Anantapur district, diamonds are picked after the rains and it is mentioned authoritatively that one such was capable of yielding a flat-cut diamond of 60 carats worth about a lakh of rupees. Prospecting by A. Ghose in the years 1910–12 disclosed that round about Viryapalli in Kurnool district, the diamond-bearing conglomerates are about 3″ to 2 ft. in thickness and yield on an average from 1/16 to 1/2 carat of diamond from a load of 16 c. ft. and that most of these diamonds were perfect crystals of fine quality, and free from flaws. There has been no proper attempt to mine diamond as it is a highly technical process requiring great skill and experience, and half-hearted efforts by amateur persons without proper knowledge have resulted in failure. The clear and flawless stones are used as gem-stones while those of poorer quality find wide industrial application as borts used in drilling bits for easy boring into rocks. Diamond powder is a valuable abrasive in the gem-cutting industry. On account of this utility of diamond, even small grains of poor quality find a ready market in India; with the progressive popularity of drilling in prospecting for minerals in the country, it should be possible to meet the local demands from a thriving industry. It is universally recognised that the possibilities of diamond in the Andhra Desa has not been properly appreciated.

Gold.

Anantapur contains some gold mines and during the early part of this century, Mr. Wetherell of the Mysore Geological Survey discovered new areas of Dharwar Rocks in which were seen ancient gold workings, probably dating back many centuries. The North Anantapur Gold Mines, Ltd., and the Jibutil Gold Mines, Ltd., carried on operations since 1905. The Gold Mines are situated in Dharmavaram Taluq of Anantapur district and produced 44,688 oz. of fine gold between 1919 and 1923 and finally ceased operations in 1925. Another Company, the Jibutil Gold Mines Co., of Anantapur, Ltd., was also in operation from 1908 to 1924. The North

Anantapur Gold Mines, Ltd., carried out prospecting in the Gooty Taluq from near Ramapuram and Venkatampalli from 1922, and extracted gold between 1926 and 1927 the operations having ceased completely in the latter year. The total amount of gold produced from the Anantapur Mines is estimated as 1,36,739 oz. Mining activity was entirely with European capital and European staff. On account of the high value gold has reached in recent years, it is likely that re-starting of gold mining will be profitable. When we develop the necessary skill and discipline to organise Mining Industry on a thoroughly scientific basis, it should be easy to minimise the overhead charges incidental to European management and carry out the work more economically without sacrificing efficiency. Even now, in the alluvials of the rivers Thungabhadra, Kistna and Godavari and in streams in auriferous areas, a number of villagers live by panning the sands and recovering gold in small quantities. They are called *Jalgars* in the Ceded Districts, and until recently, they were a thriving community who followed this trade traditionally. The mining rules enforced strictly on this indigent folk, has resulted in their giving up the trade. It would be to the advantage of the country if recovering alluvial gold by individuals is encouraged, as this will afford considerable employment to a number of starving villagers, especially in those arid areas.

Graphite.

Small quantities of graphite have been extracted in recent years in Godavari and Vizagapatam. Graphite is found in the Khondalites of Vizagapatam, Godavari and Kistna Districts in lenses, bands and veins. It is necessary to recognise that proper prospecting has not been carried out for this mineral and that the potentialities are really great in the above named Districts.

Graphite has a wide industrial application. It has the same chemical composition as diamond, and consists of pure carbon. It is most interesting that the element carbon should exist in two forms, so widely different in their physical characters. One is very soft and the other is the hardest known

material. One is black and opaque, the other is transparent white and brilliantly lustrous. This difference in their physical character is due to a fundamental difference in the arrangement of the atoms in the carbon molecule. The diamond molecule contains four atoms of carbon arranged as a tetrahedron or four-faced solid; whereas the graphite consists of six atoms of carbon arranged in the same plane as a hexagon.

Graphite finds immense use in industry. As is well-known, black-lead pencils are all made of graphite. It is one of the best known lubricants, particularly for high temperature duty. Its chief use is as a refractory material with fire-clay for the manufacture of crucibles. In view of the fact that in Godavari district fire-clay is found in the Gondwana Formations and graphite exists in proximity, this industry can thrive with proper direction and control. A wide field for the manufacture of pencils, paint, stove polish and crucibles exist in our area.

Iron.

On account of Iron ores being found extensively in Bihar and Orissa in proximity to the coal belts, two large companies manufacturing iron and steel exist in that part of the country. In Andhra Desa iron is found in several geological formations, and in historic times, local smelters utilised this raw material extensively, and innumerable smelting sites are met with in several districts. Whereas it would be risky to venture on large scale industry for iron manufacture in the area, it should be easy to revive the local furnaces and give impetus to the cottage industry with proper protection. It would be easy for the local smelters, by importing some scientific principles in the construction of the furnace, to supply the immediate demand by local manufacture at competitive prices. The steel made from the iron in these parts in historic times was considered to be of excellent quality and found its way into the markets of Persia, Turkey, Arabia and the Levant. A sympathetic policy conceived in the interest of the small scale producer, if inaugurated before the old tradition

of this rural industry becomes completely obliterated, will bring succour to starving artisans in the villages.

Manganese.

The Vizagapatam District of Andhra Desa has played a prominent part in the contribution to the production of Manganese in India. The Vizianagaram Mining Company floated as early as 1895 is still thriving and has afforded employment to a large number of people in the district, but the enterprise has been European. The production between the years 1929 to 1933 from Vizagapatam amounted to 67,862 tons, from Sandur to about 1,600,000 tons and from Bellary, Cuddapah and Kurnool to about 14,500 tons. There was a considerable decrease of output in Vizagapatam district and in Bellary during this quinquennium, but an increase was noted from Sandur and to a minor extent from Cuddapah. The present armament race in Europe has again improved the market and the effect is already noticeable in the Indian production.

India supplied about 40 per cent. of the world's requirements of manganese till about ten years back ; and in one year as much as about 57 per cent. of world's demand was met from this country. But after the re-entry of Russian manganese in the world's markets India's contribution diminished between the years 1919 to 1932 to 12·5 per cent. of the world's output. This loss of market is no doubt due partly to want of healthy organisation and understanding amongst the producers, and proper direction by the Government. As long as there is no national policy with regard to the exploitation of minerals, mining would always be a specially hazardous gamble. The whole question of mineral economics is so intricate and at once so important to the nation's regeneration that only a far-sighted policy, based upon a thorough survey of the potentialities can lead to the industrial and economic prosperity of the country.

Only a fraction of the manganese-ore actually produced in India is consumed in the country and being used for making

ferro-manganese which goes into steel manufacture. Instead of having to export all the raw materials to other countries and getting them as finished products, it would be more advantageous to this country to have the raw materials utilised for her industrial development. The most important use of manganese is as an alloy of iron. Manganese steel containing from 10 to 15 per cent. of manganese is permanently hard and very serviceable in many ways, such as, for the manufacture of rails, crushing machinery etc. In the metallurgy of iron also, manganese is used in small quantities as a controlling factor in pig-iron and steel on account of its properties as a de-oxidiser and de-sulphurizer.

In chemical industries it is largely in demand for the manufacture of chlorine; oxide of manganese (pyrolusite) is used for de-colourising, and as de-polariser in dry batteries.* It is used in glass and porcelain industries as a colouring agent. Potassium permanganate requires a good quantity of manganese-ore as raw material. There is a vast industrial field for all these in the area, especially as the other raw materials are also found in proximity. During the years 1929 to 1933 Manganese Mining Industry gave, on an average, employment to about 2,500 persons daily in Andhra Desa.

Mica.

Two varieties of Mica have large uses in industries, *viz.*, the *muscovite* and the *phlogopite*. Muscovite is found in Nellore District and phlogopite in Vizagapatam district. The possibilities of phlogopite mica in Vizianagaram Samasthanam seem to be bright; and careful spade-work will prove workable deposits. On account of the rarity of its distribution and the great demand it has in electrical industry, it will be easy to find ready market for phlogopite. The muscovite mica quarried in Nellore between

* Professor S. Bhagavantam of the Andhra University conducted detailed and extensive experiments in the laboratories of the J. V. D. College of Science and Technology in the manufacture of dry batteries from the manganese oxide of Vizagapatam District and graphite of Godavari District and has succeeded in making dry batteries which equal the best types imported from abroad.

the years 1929–33 totals 44,874 cwts. valued at Rs. 23,61,483 and comes next in importance in India to the Bihar mica as regards the quantity of production. Practically all the mica that is exploited here is exported to foreign countries. This is a great national loss. The uses to which mica can be put are numerous. The mica chimneys for petromax and other lanterns used so extensively in this country are all now imported and it would require but a little organisation to initiate this industry. The greatest use of mica is for electrical purposes. Its highly insulating property combined with flexible immunity to cracking on sudden temperature variation and the ease with which it splits into thin sheets give it the unique value in electrical appliances and in dynamos, transformers, condensers, &c. In the neighbourhood of Mica Mines in Nellore district, one walks over large mounds of small flakes of mica thrown away as useless material. These are admirably suited for making what are called micanite tubes which are electrical insulators prepared by compressing films and flakes of mica with shellac as a binder. Micanite tubes are extensively used in electrical industry in high tension electrical appliances, and have a great demand. We have already the necessary raw material in the area. The Micanite industry has given elsewhere an economic value to the rejected waste. No elaborate machinery is required for its manufacture and a co-operative organisation can develop it as a cottage industry and can afford employment to a large number of people without enforcing factory conditions on them. There are innumerable little uses to which mica could be put, such as, in the manufacture of lantern slides and slides for making microscopic specimen. All these require but little initial outlay and can be developed as a cottage industry. It is also possible to make art-ware from these for decorative and ornamental purposes, though it may not be anything very considerable. That the ancients appreciated this aspect of its use, is evident from an account left by Pliny about two thousand years ago. The waste scrap of mica lends itself to be fashioned into non-conducting

packings, as jackets for boilers and steam pipes. On account of its being a poor conductor of heat, scrap mica interleaved in the ceiling or used as a screen is claimed to perceptibly keep out heat during the summer. It is also used with graphite as a lubricant for bearings working under heavy pressure. It serves as base for soap and as inert absorbent medium for taking up nitroglycerine in the manufacture of dynamite. Fire-bricks made out of compressed mica waste have been proved to be of great utility. In the Ayurvedic system, mica has been used largely in the preparation of medicines.

Though the mica mines have given employment to a considerable number of people, it is capable of supporting several times that number if the fullest advantage is taken of its industrial possibility. The finished products out of these are for the most part now imported from foreign countries. Mica industry can be developed on both a large scale and a cottage industry scale in Andhra Desa, which is a well favoured part in South India. With regard to the distribution of this finished product, a vast field already exists in this country. India contributes about 25 per cent. of the total mica produced in the world. It is a tragedy that India holding the monopoly for shellac in the world and producing an enormous quantity of first rate mica, is far from being the leader of the micanite and mica industry in the world, but practically imports all her requirements.

Salt.

Along the coastal regions of the area, salt is made from sea water in several localities. Prior to the conversion of Vizagapatam into a harbour, the saline swamps and backwaters called "Opputeru" supported a flourishing salt industry at Kharasa. The production of salt is a Government monopoly and is regulated by stringent rules. In several parts of Andhra Desa, especially in the Ceded Districts, salt industry thrived from time immemorial and supported a number of labourers. This trade has been killed after the introduction of the Salt Act. Saline efflorescence, salt-licks and salts from soil as

well as brine springs, in all of which the area abounds, afforded the raw material. Through lixiviation process all the salts were taken in and evaporated in pans. It would be of interest to note here that in the Hyderabad State, where no Salt Laws exist, the industry is still thriving in the districts of Raichur and Gulbarga, affording employment to a large number of men during the dry months when agricultural pursuits are almost at a standstill. In spite of the competition from other manufacturers, the local salt is able to hold its own. His Exalted Highness'es Government are taking steps to encourage this cottage industry. A detailed and extensive survey was carried out to test the potentialities of this industry by the Geological Survey and Industries Departments, and stack evaporation experiments similar to those in vogue in Bohemia, were conducted to facilitate rapid evaporation of the dilute solutions; the results of all this work have been most encouraging. In several areas in Andhra Desa, salt can be manufactured on a cottage industry scale and it would at least supply the local requirements. This measure would be a great boon to the indigent villager where saline efflorescences now go waste. In Hyderabad, nitre, tannery salts and edible salts are prepared for local requirements. On an average, a man earns monthly from Rs. 12/- to Rs. 15/- even by following his crude methods of salt manufacture. He can easily increase this income if he is allowed the facilities of the stack evaporation methods for which raw materials are within easy reach. We have it on record that similar salt industries thrived in the Ceded Districts before the introduction of the Salt Act.

Zircons.

Some samarskite has been reported from Sankara Mica Mines in Nellore District which contains uranium and some zircon. Zircon is used for the preparation of zirconium oxide, a highly refractory material suitable for crucibles and high temperature cements. The Industrial possibilities of these deposits require careful investigation.

Asbestos.

The important role played by asbestos in modern industrial development is generally well-known. The most important deposits in India, from the point of view of quality, are those in the Pulivendla taluq of the Cuddapah district, from where 200 tons of excellent chrysotile asbestos valued at Rs. 27,954/- was extracted between 1924 and 1930. The asbestos occurs at the junction of limestone with an intrusive dolerite sill (the basic rock). A large number of new localities have recently been discovered and the prospects of getting fairly large supplies are bright.

Being a non-conductor of heat and a refractory, asbestos is used as packing material for steam pipes. Fire-proof bricks, cloth, ropes and various other materials are made out of this. As clay of pure type is also found in the area, it should be quite easy to make asbestos tiles and cement from the poor quality of the asbestos and ropes and similar goods for electrical and motor industry from the stronger fibres of chrysotile asbestos.

Barytes.

Barium sulphate or barytes is now chiefly used on account of its high specific gravity for the weighting of mud fluid in rotary drilling. The better grades are used as inert filler in paper, cloth, linoleum etc., and as a base in paint industry. The last of these is by far the biggest consumer of the barytes produced. The more economic use, however, to which this can be put is for the manufacture of what is called commercially *'lithopone'* which is a mixture of 70 per cent. of barium sulphate and 30 per cent. of zinc sulphite and zinc oxide. *Lithopone* is used abroad in the manufacture of paints and high grade rubber goods, such as motor tyres.

Between the years 1929 and 1933, the Ceded Districts produced 19,946 tons of barytes valued at Rs. 2,24,207/- and practically sent the whole of it to outside the Andhra Desa for consumption. Of what great economic value would it have been to the people, had this all been used for local industry! Barytes occurs in the Ceded Districts as a replacement product and fissure veins in limestones and dolerite basalts.

In Anantapur the chief deposits are at Narajannupalli, Mutsukotu in Tadpatri taluq. It is estimated that about 75,000 tons occur at Mutsukotu only. In Cuddapah, at Kothapally in Pulivendla taluq, barytes occurs as a vein in basalt, the estimated quantity being very large. The barytes here occurs both in the basic rocks in traps and in limestones. The chief deposit in Kurnool district is west of Bethamcherla and in several villages in Dhone taluq and they all occur in the limestones of lower-most Cuddapah series. Another deposit in Jallapalli cheroo in Kambham taluq is also important. It appears therefore that every effort should be made to start local industries for the utilisation of these valuable deposits.

Bauxite.

This is the name given to aluminous clay with varying percentage of other ingredients, the most important of which is iron. It is believed that the laterites of Vizagapatam, Godavari and Kistna districts are capable of yielding local deposits of bauxite of the required quality and quantity. The uses of bauxite are numerous, and the market for the products, rich and ever growing. In the manufacture of refractories, abrasives and cement, they are in great demand. And on account of the good quality of the Indian bauxite they are much prized in foreign markets.

Bauxite is the chief source of the aluminium oxide used in the manufacture of aluminium. The other raw material necessary is cryolite, a naturally occurring double fluoride of aluminium and sodium, of which the only known deposits are found in Greenland, a possession of Denmark. But now-a-days synthetic cryolite is very widely used. India has excellent bauxite deposits and yet has no aluminium reduction works. Russia has rapidly developed a great aluminium industry within ten years using inferior grades of bauxite; and Japan has also recently become a producer of aluminium using aluminous clay and alunite from her Dependencies. Though a new industry will have to face severe and even devastating competition from the foreign aluminium interests which have the monopoly of the Indian market, a strong Indian company

can withstand it, given Government aid, especially in tariff, during the early years.

Within the limits of Andhra Desa, the finest variety of building stones are to be had from all the geological formations.

Building Stones.

The pink and grey granitoid gneisses of Nellore, Bellary, Anantapur, Kurnool, Guntur and Kistna districts, the Khondalites of Vizagapatam, parts of Godavari and Kistna districts, the limestones of the Cuddapah and Kurnool formations, and the Gondwana sandstones of Godavari and Kistna, constitute some of the finest building materials. Their possibilities in construction and durability are evidenced from the beautiful architectural masterpiece in the temples of Andhra Desa, such as Amraoti, Nagarajunakonda, Srisailam, Simhachalam &c.

The Palnad limestones are unrivalled in India for their beauty and durability; and I say this without the least exaggeration. Beautiful slabs, multi-coloured and of various pleasing patterns, are quarried on a very small scale near Rentichintala in Gurjala taluq of Guntur district and made into paper weights or table tops under the patronage of Missionaries. Having had the opportunity to visit both the quarries and the places where they are made, I feel that here is a field for an enterprising person to draw the attention of the aesthetic public to the value of this beautiful stone. These deposits being situated in the interior in what is dubbed as a backward area, have not had the publicity that they deserve. To dilate on the possibility of the building stones in this area is to digress on the obvious.

The grey to black Cuddapah-Kurnool limestone slabs are extensively exported all over the Madras Presidency for flooring under the well-known name of '*Cuddapah slabs*'.

Within Andhra Desa, marbles are found in Vizagapatam hill tracts in white, green and grey colours and also in parts of Godavari. Around the Burra caves in Anantagiri which I visited several years ago, when I was a student of Geology, I found these deposits to be

Marbles.

of massive proportions. A reputed economic geologist of South India told me that they were of a very fine quality and can stand comparison with the celebrated Makrana Marbles of Jodhpur in Rajputana, which have been used in the Victoria Memorial in Calcutta. It can be used for building, decorative purposes and for statuary. At present a great deal of the marble is imported from Italy, but the working of these deposits can easily take care of that demand, at least in the Madras Presidency.

Raw Materials for Paint Industry.

Yellow ochre from Madhavaram in Kurnool district, grey ochre in Nallakonda in the same district, lithomargic clays distributed all over the Andhra area afford attractive raw material for paint industry. It is a matter of surprise that with barytes and ochre occurring almost side by side, we should still export both of these to be made into paints and sent us back.

Phosphates.

The mineral apatite is known to occur in Nellore district in association with mica and in the Kodurite series in Vizagapatam district at Sitharampuram twenty-five miles N.W. of Vizianagaram, close to the road connecting Vizianagaram and Ananthagiri. Thick viens, about a yard in width are said to occur here. The material has been declared to be very suitable for the manufacture of super-phosphate. Sulphuric acid is necessary for the preparation of super-phosphates, but this is now extensively manufactured in India mostly from imported sulphur, though gypsum and sulphide minerals can also be used as raw material. It is to be regretted that, when agriculture is the main occupation for millions living in the area and when the raw material is available for the manufacture of these fertilisers, there is still not even an attempt to start a suitable concern for the production of artificial manures.

There are other economic mineral possibilities which I have not dilated upon. The various clays in the area will be useful for a ceramic industry. There is enough limestone and clay in the Andhra Desa to start manufacture of lime and

cement not only for local consumption but also for export to other parts of India and the neighbouring countries. The sandstones and quartzites in the country should be searched for suitable materials for glass manufacture.

Conclusion :—In the course of the lecture, I tried to give a bird's eye view of the immense possibilities for mineral industry in Andhra Desa. I would like to emphasise again that within the present political boundary of Andhra Desa, there is an abundance of mineral wealth, far in excess of what you see in any comparable area in the Madras Presidency. The harbour at Vizagapatam, the ports of Cocanada and Masulipatam and the navigable rivers that flow through the country afford convenient means of transport for the development of the industry. The most important requisites, however, are first of all, a very thorough exploratory work entailing detailed geological prospecting by qualified, conscientious and enthusiastic geologists. What we know of most of the mineral resources now are the very barest outlines. It is believed even by the most conservative of Geologists that in our area we have not even touched the fringe of the potentialities. Several of these industries can be organised on a small scale as cottage industries, eliminating the sordidness of factory conditions and giving a great scope for co-operative organisations, advising and aiding these concerns so as to gather raw materials, to secure markets and prevent over-production and cut-throat competition. It is to be hoped that the new popular Government would be able, if not to finance and run industries by itself, at least to encourage others and give the infant industries the necessary encouragement and protection. If the people have as their motto self-sufficiency first, and can feel that all that they need can be obtained, poverty would be considerably reduced and unemployment minimised. The educated and trained men that now exist without work will be found far too small in number for the demand.

A word of caution is also necessary with regard to the exploitation of the country's resources. As it is, there is no

national policy whatsoever guiding the exploitation of our mineral wealth. It is for this reason that failures, liquidations and depressions are so frequent and we are still mere producers and exporters of raw materials.

In view of what is happening before our very eyes in the field of mineral industries in the Soviet Republics and in Japan, a co-ordinated programme of industrial expansion can be made to yield fruitful results in the astonishingly short period of a decade. We are at present suffering a double loss in exporting our valuable raw materials and in importing them back again at a very high cost as manufactured products. It should be clear to every one that at this rate we shall soon have spent all our valuable assets and be left only with the poorer resources. But I am confident that our industrialists and Government will soon muster their forces and start on a programme of ordered, well-planned and well-co-ordinated scheme of development, thus ensuring our well-being and prosperity.

Ananda Press, Madras.

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